Power and The Engineer

Vol. 32 NEW YORK, OCTOBER 25, 1910 No. 43

BEING in business for the sole purpose of generating and selling power, the central-station people go about their work in the most approved manner. They get the best men that they can obtain to direct the running of their plant, which they so locate and design as to yield the highest results.

Further, they hire clever solicitors to get business—men who can so present facts that central-station service seems highly to be desired to all who accept their logic without investigation on their own account.

As a consequence, one after another of the isolated plants is taken over by the central station. And once an isolated plant "gets out of the game," like a noted pugilist, it "never comes back."

A time was when the central-station solicitor was handicapped in his "roundup" of isolated plants by the heating problem.

But this time has passed.

Central-station steam heating is the solution.

Just run a steam main of the required size into the basement at the same time that the conduits are put in and the boilers and the *engineer* as well as the engines can be dispensed with.

So many private plants are going "by the board" that the matter is becoming one of real concern to the engineers of the cities.

Except in a few special cases the cost of heat and power from the central station is much higher than that of a private plant properly installed and operated.

Why, then, are so many private plants being abandoned for central station service?

Is it because central station service is more reliable?

Or because it is cleaner?

Or because it is safer?

Is it because the owner of the private plant hears only the central-station side of the case?

Or is it because many private plants actually are run so inefficiently that their operation does cost more than central-station service?

It is dangerously easy to neglect the little bits of things—to delay attending to them. Individually, they do not amount to enough to talk about. Collectively, they often mean the success or failure of a plant.

Eternal vigilance is the price of success in any business; in none more so than in steam engineering.

Any engineer who by "falling to sleep" on his job makes it possible for the central-station steam and electric mains to force their way into his plant, not only sleeps himself out of a position but makes the central-station argument against the private plant just so much stronger, and consequently the task of other private-plant engineers so much harder.

On Saturday night, October 29, an open meeting will be held in the Auditorium at the United Engineering Societies building, 29 West Thirty-ninth Street, New York City, under the auspices of the Blue Room Engineering Society.

Two interesting papers will be presented: one on "Isolated Plants versus Public Vendors of Electricity" and the other on "Heat, Light and Power in Buildings."

All who are in any way interested in these subjects are earnestly urged to be present.

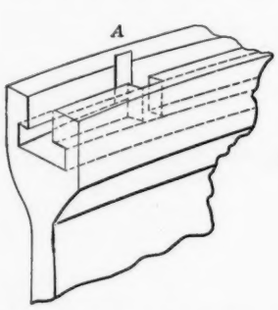
The gist of one of these addresses is hereinafter presented. An abstract of the other will appear in a later issue.

The Works of Escher Wyss & Co.

By F. R. Low

A general description of the works at Zurich where Zoelly turbines as well as rotary air compressors and water wheels are manufactured. Some turbine details and a general description of the air compressors.

This works had its beginning in the establishment at Zürich of a small plant for the manufacture of textile machinery by Hans Kaspar Escher in 1805, about the time that John Cockerill was developing the textile-machine works which has grown into the great establishment at Seraing. With the development of the factory system this led naturally into the manufacture of transmission machinery, steam and hot-water heating systems, paper-mill machinery, engines, boilers and water turbines, in the manufacture of the latter of which the works attained especial renown, perhaps by reason of the numerous water powers in Switzerland.



Special Distance Piece and Wedge
Power

FIG. 1. SECTION OF RUNNER AND DETAILS OF DISTANCE PIECE AND WEDGE

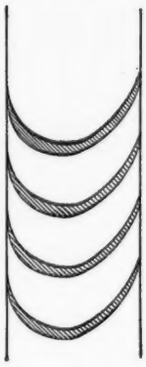
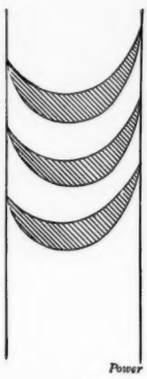


FIG. 2.



Power

FIG. 3.

The present works includes an area of 100,000 square meters, 42,000 of which are covered with buildings. The company has also a plant at Ravensburg, Germany. All of these large Swiss companies have German establishments in order to keep their German patents alive, to qualify for German government work and to avoid duties. Escher Wyss & Co. employ some 1600 hands at Zürich and 600 at Ravensburg.

We were welcomed to the Zürich works by Managing Director Zoelly, the inventor of the turbine which bears his name and which is made not only by Escher Wyss & Co., but by numerous licensees, including the Cramp Ship Building Company in "the States." The Société Alsacienne, at Belfort, France, another licensee, is just building three generating sets, consisting of 22,000-horsepower turbines attached to generators of 10,000 kilowatts capacity and capable of carrying a 50 per cent. overload, for the Compagnie Parisienne de Distribution Electrique, at Paris; and Schneider & Co., at Creusot, other licensees, are building two sets of the same size for the same station.

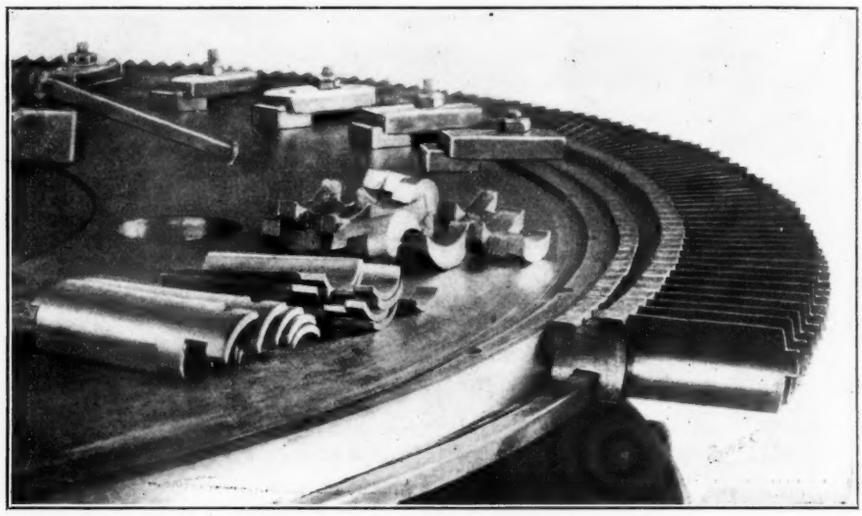


FIG. 5. OLD METHOD OF BLADING THE RUNNER

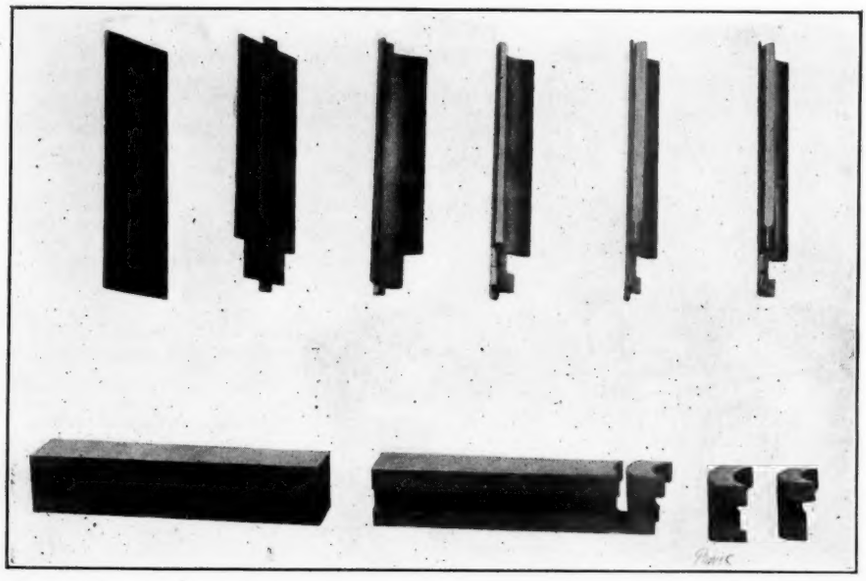


FIG. 4. SUCCESSIVE STEPS IN THE MANUFACTURE OF BLADES AND DISTANCE PIECES

THE ZOELLY STEAM TURBINE

Ingenieur Albert Huguenin conducted us through the works and showed us the turbines in process of construction. The Zoelly is a multistage impulse turbine with a single wheel in a stage and full admission. Such a turbine was patented by Réal and Pichon in France in 1827, and has been made familiar in America by Rateau, from whose turbine it differs only in constructional details and in the fact

Power

FIG. 6. SPECIAL SHROUDING FOR MARINE TURBINES

that fewer stages are used. The suit for infringement has, however, recently been decided in favor of the defendants. The runners are made of disks of Siemens-Martin steel with a T-slot cut in the circumference, as in Fig. 1.

"Sheet" blades are used in land turbines, i.e., blades of uniform thickness all the way across, as in Fig. 2, while those thickened in the center to make the passages parallel, as in Fig. 3, are used in marine turbines. The former are made of nickel steel on account of the higher steam velocities, and the latter of bronze, which is allowable with the smaller steam velocities. The longer blades are thicker at the base than at the outer end, and the base of each blade, as well as of the distance piece between them, is fashioned into a T to fit the groove in the disk, as shown in Fig. 4, which shows the successive stages of their manufacture. These were formerly set into a built-up disk, as shown in Fig. 5, slotted segments being bolted on to hold the blades in place. In their newer practice, however, a slot is cut in the rim of the disk, as at *A*, Fig. 1, into which the blades and distance pieces are alternately slipped and pushed along. The gap is closed by a special distance piece with a side projection to close the gap, cut away so that at one end it projects into the T-slot and is thus held in place. Between this block and the blade is driven a circular wedge, fitting the face

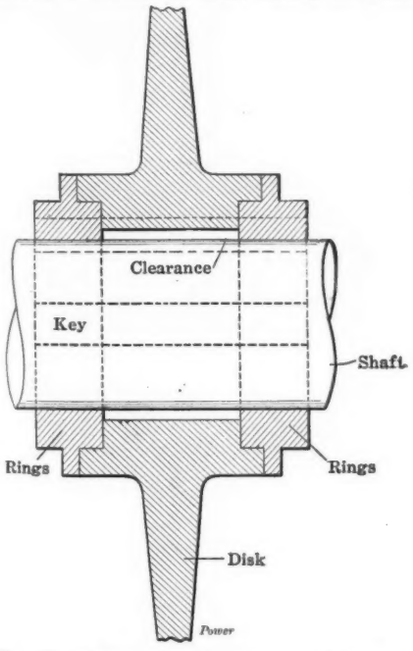


FIG. 8. METHOD OF ATTACHING DISKS TO SHAFT

of the blade, which packs the circle of blades and distance pieces closely together, and which is held in by having the face of the contiguous distance piece staked down upon it.

The special shrouding for marine turbines has the section shown in Fig. 6 and is punched through the central rib to take the projections upon the tops of the blades which are riveted over. In case of rubbing it is these raised portions which first come into contact. There is, however, from 3 to 6 millimeters (0.12 to 0.24 of an inch) radial clearance so that the danger of contact between the blades and casing is very remote and has never occurred up to now. The axial clearance is about the same. Fig. 7 shows one of the two marine turbines for the German destroyer "G 173," which have given the following results: Load, 7080 brake horsepower; speed, 768 revolutions per minute; pressure, 202 pounds absolute; temperature at inlet, 360 degrees Fahrenheit; back pressure, 4 inches mercury; thermal efficiency, 63.7 per cent.; steam consumption per brake horsepower per hour, 12.8 pounds.

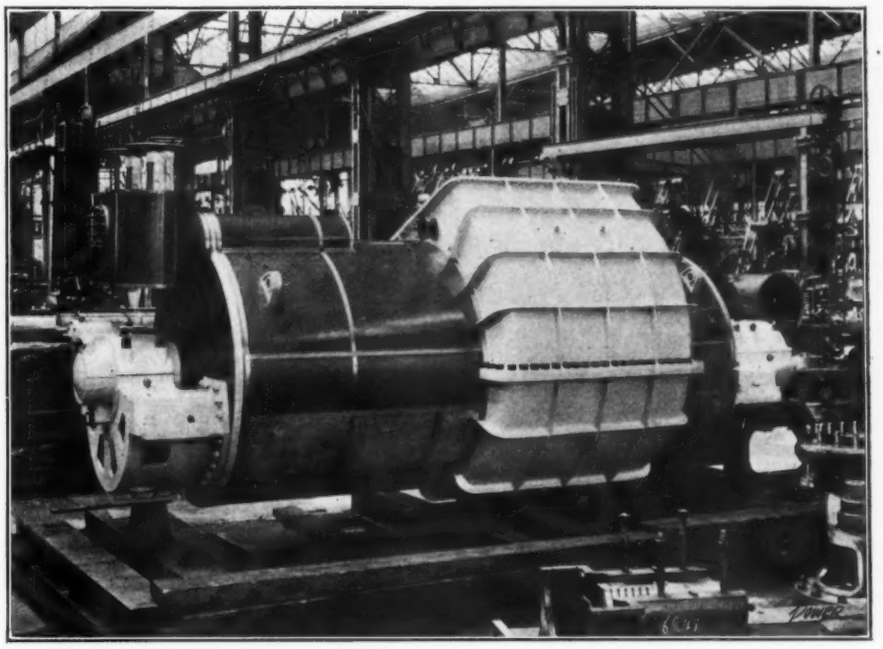


FIG. 7. ZOELLY TURBINE FOR GERMAN DESTROYER "G 173"

The disks are finished all over and carefully balanced and are carried upon rings keyed to the shaft, as shown in Fig. 8. The object of this construction is to avoid the stiffening effect upon the shaft and the raising of its critical speed which would be produced by a continuous line of disk bases keyed thereto. As many of the shafts are run above their critical speeds, it is desirable to keep the latter down and to have as large a working leeway as possible.

As the fall of pressure between the stages is always less than 40 per cent. of the initial, the nozzles formed by the guide vanes must be converging. These are made by casting pieces of sheet steel bent to the right contour, as shown in the sections of the stationary guides in Fig. 9, into the cast-iron disks which separate the chambers. This foundry work is admirably done. Fig. 10 shows the mold containing the steel guide vanes set in the sand. The casting is like the two front sections in Fig. 11, which are placed between the rotary disks in the manner shown in Fig. 12, where the solid black sections are those of the runners and the cross-hatched dividing walls between them those containing the guide vanes, in such a way that the steam which they deliver impinges upon and drives the rotor wheels. Furthermore, the entering edges of the guide vanes are so fashioned as to receive the steam as it leaves the rotary vanes and preserve its residual velocity. See Fig. 9.

The high-pressure steam is received in the circular chamber *A*, Fig. 12, and the greatest allowable ratio of expansion is used in the first stage in order to reduce the pressure as much as possible before it reaches the stuffing box. Carbon rings

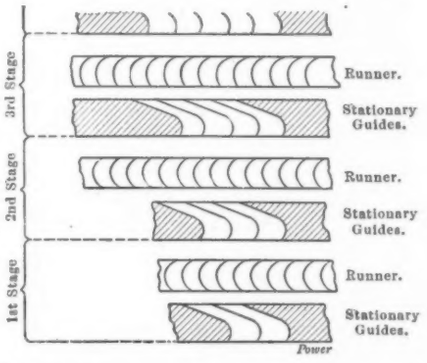


FIG. 9. DIAGRAM OF BLADES AND NOZZLES

are used for packing between the first two stationary disks and the shaft, the remaining disks being packed with a number of copper rings let into the disk, forming a labyrinth. Carbon rings are also used in the stuffing boxes.

The fall in pressure between the stages is so divided as to produce veloc-

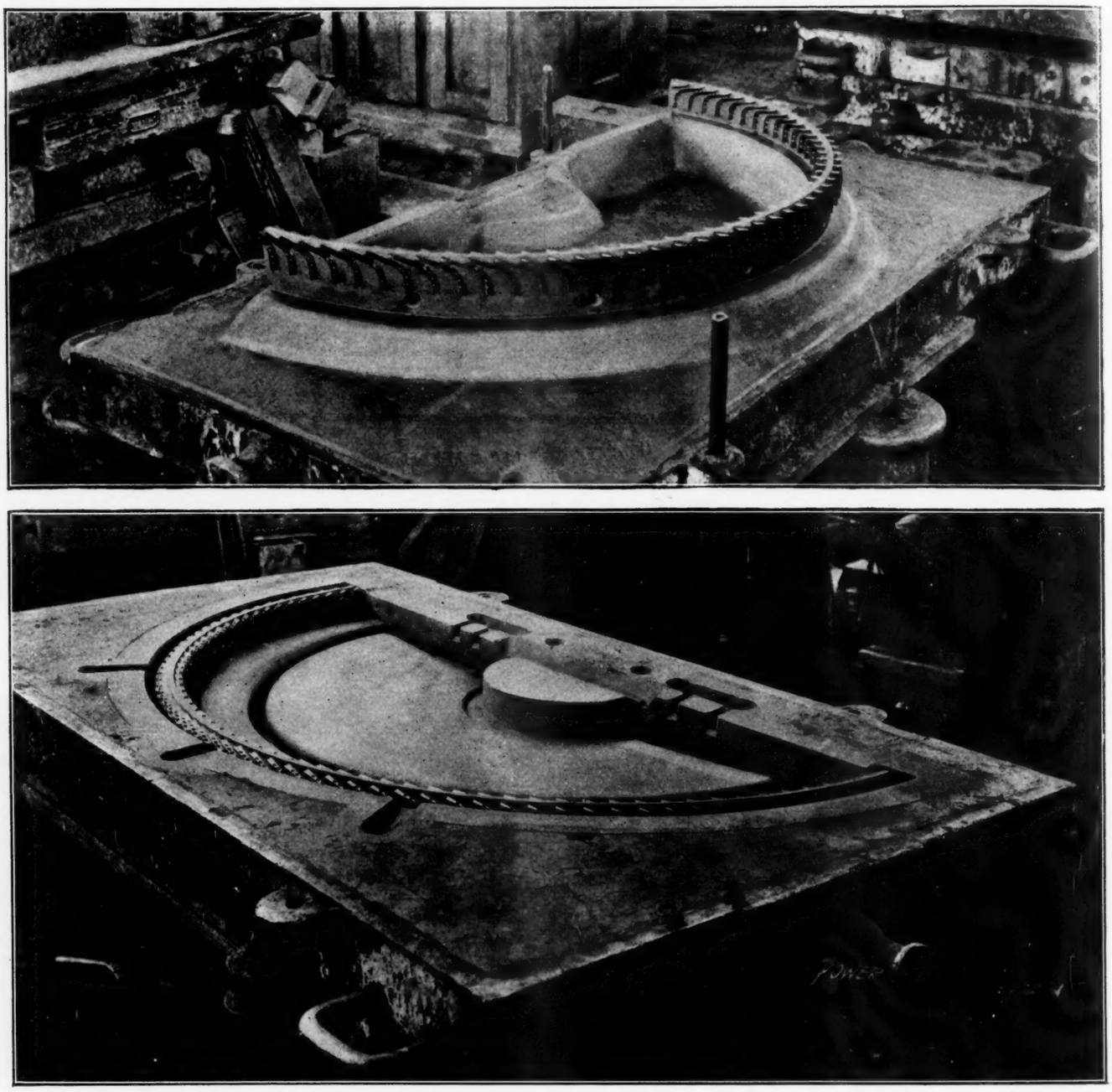


FIG. 10. GUIDE-WHEEL CASTINGS IN THE FOUNDRY

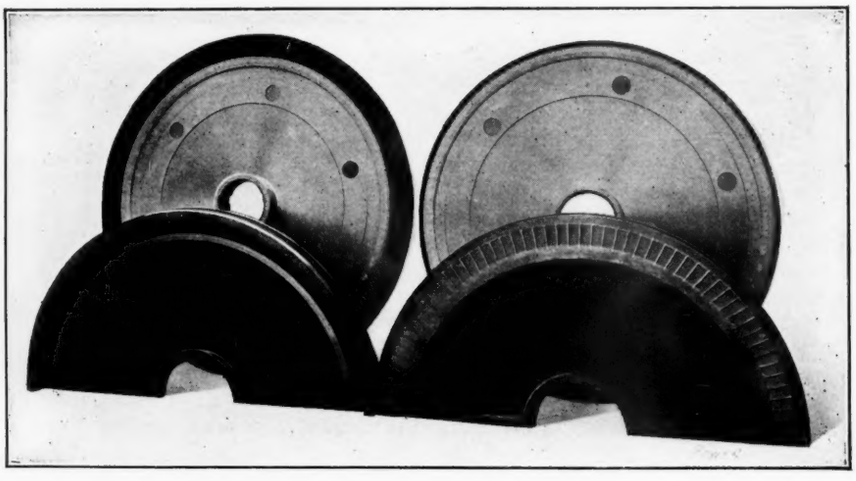


FIG. 11. RUNNERS AND GUIDE WHEELS

ities of from 300 to 350 meters (965 to 1125 feet) per second and the blade velocity is from 140 to 145 meters per second, or 460 to 475 feet per second, giving ratios of blade to jet velocities of 0.415 to 0.465. The largest disks are 2200 millimeters (7.2 feet) in diameter at the centers of the blades. These high velocities, the result of considerable expansion ratios between the stages, allow the total expansion to be completed in a limited number of stages. Turbines running at 3000 revolutions, for 200 to 8000 horsepower, are generally built with 8 wheels. Those which run at 1500 turns have 10 to 12, and those for 5000 to 8000 horsepower at 1000 turns 16 stages, with modifications, of course, for special cases of initial and terminal pressure. The ratio of expansion never exceeds that

which will take place in a conveying nozzle, and the nozzles are made as previously described with converging walls, parallel at the point of issue.

The regulation is effected by throttling, the admission valve being operated by a piston actuated by oil pressure under the control of the governor, through the arrangement, familiar from its use in damper regulators, whereby the movement of the main valve closes the small valve which has been opened by the governor to produce that movement. Oil- and mechanically actuated safety devices are provided which close the admission valve automatically when the speed exceeds a range of 10 per cent. above the normal. A small motor upon the governor allows the speed to be varied 5 per cent. from the switchboard.

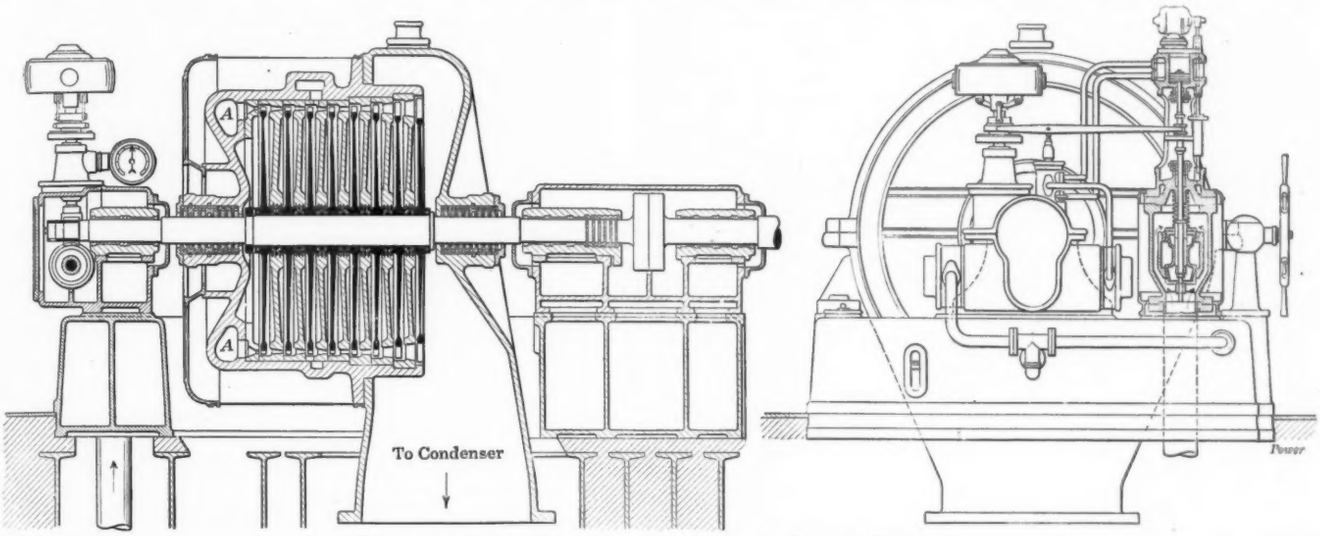


FIG. 12. SECTIONAL AND END VIEWS OF ZOELLY TURBINE

Lubricating oil is circulated by means of a pump geared to the main shaft. As this pump will not operate properly until the turbine has attained some 500 or 600 revolutions, a small auxiliary pump, turbine-driven for the larger and hand-driven for the smaller machines, is installed in one corner of the base. The oil-cooling coils are also placed in the bases of the larger sizes, the water being inside the coils. The case is made in two parts with no transverse joints, the single central longitudinal joint being

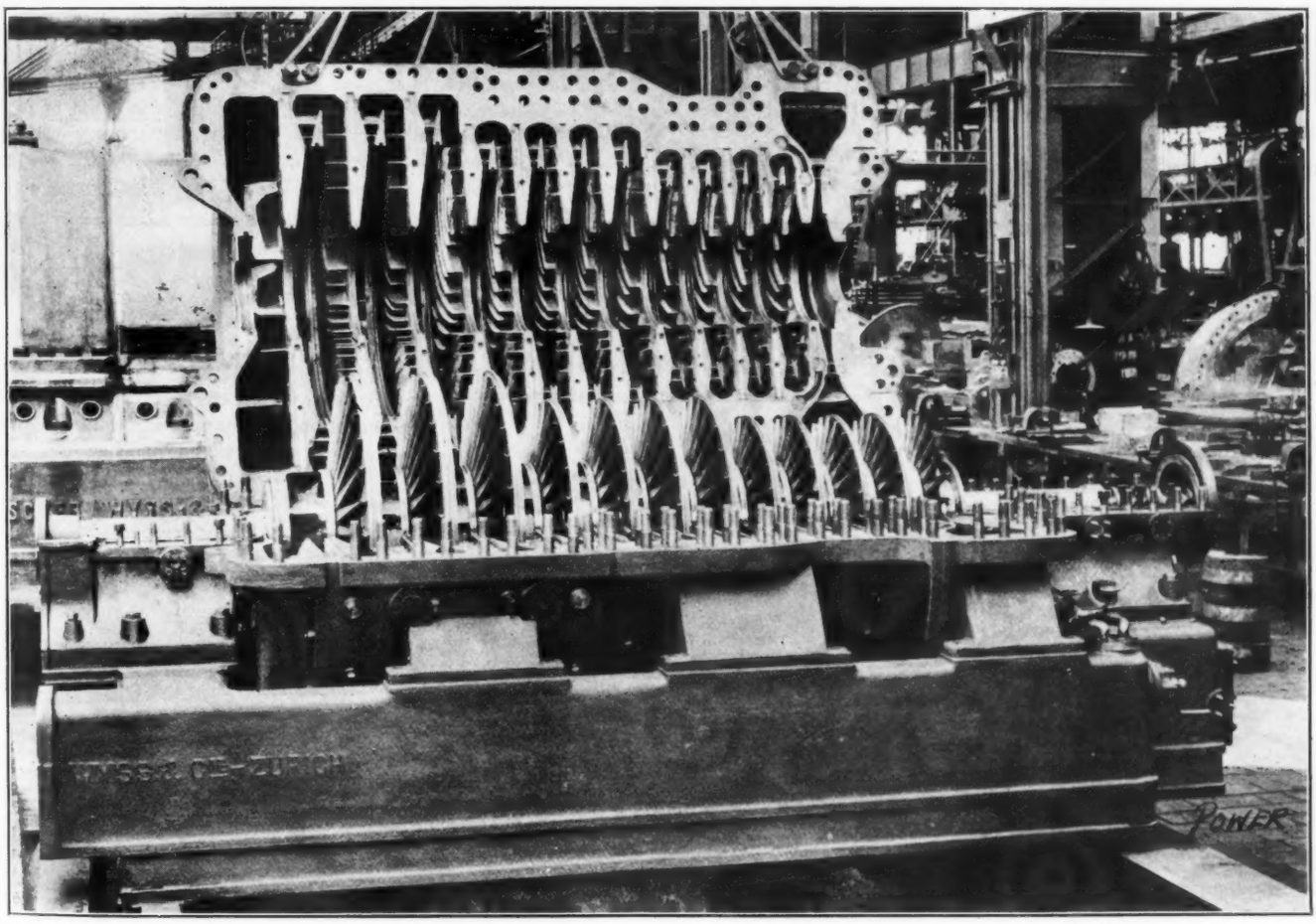


FIG. 13. A 12-STAGE ROTARY AIR COMPRESSOR

made metal to metal. It is anchored at the low-pressure end, the case as well as the shaft being free to expand lengthwise. These turbines have attained efficiencies of 6 kilograms (13.2 pounds) of steam per kilowatt-hour with steam of 150 pounds pressure, 165 degrees Centigrade (300 degrees Fahrenheit) superheat, and 96 to 97 per cent. vacuum. The largest units yet made at these shops are of 10,000 horsepower, but larger units of the same type are being made elsewhere, as above mentioned.

Rotary Air Compressors

Imagine a hall 30 feet wide, 10 feet high and 100 feet long. A quantity of air which would fill this chamber at atmospheric pressure must be compressed into half that volume, i.e., to a pressure of from 12 to 18 pounds every minute, to furnish the blast for a furnace producing 180 tons of iron in 24 hours. This is usually done by large blowing tubs with reciprocating pistons, but as another instance of the tendency to handle fluids by whirling rather than by squeezing them, by the kinetic rather than by the static method, we were shown a three-stage rotary compressor or blower for direct connection to a steam turbine which will do this work, when running at 2400 to 2850 revolutions per minute, with a weight about one-fifth of that of the reciprocating outfit required to do the same work and using from 1700 to 2200 horsepower. These blowers are made for all sorts of service and it is possible to compress with them to a pressure of 140 pounds with a capacity of not less than 6000 cubic feet of free air per minute. The internal arrangement of a 12-stage is shown in Fig. 13. The air entering at the left is taken in at the base of the tapering wings which run close to but not, of course, in contact with, the tapered faces of the hollow partitions, through which flows the cooling water. The passage contracts toward the points of the vanes, as less section is required to pass the same quantity of air at the increasing velocity. The air is delivered from the tops of the vanes into passages of increasing section formed by the stationary guide vanes seen in the casing, and its velocity changed into pressure. The process is repeated in each stage. The blower illustrated will compress 5300 cubic feet of free air per minute to 85 pounds per square inch when running at 4000 revolutions per minute, requiring 1100 horsepower. These blowers are built with an efficiency of 63 per cent. referred to the isothermal curve.

Waterwheels

For moderate heads, Escher Wyss & Co., furnish turbines of the Francis type. They have ten sets of 5000 horsepower each in hand for Laufenburg-on-the-Rhine, where they have to handle up to 100 cubic meters of water per second through the minimum head of 3.5 meters in each wheel, the normal head being about 10 meters. Numerous other sets are in process for use from Norway to Mexico.

For high heads they use the Pelton impact type. The highest head yet dealt with is that at Adamello, Italy, where under a head of 950 meters (3230 feet) 6500 horsepower is produced by a single jet having a diameter of 130 millimeters (5.2 inches). Six single-jet units of this capacity were furnished. Under this immense head the water passing through the nozzle issues like an immense glass rod and it is difficult to conceive that its mass has absorbed over 6500 horsepower to get it into motion and is ready to deliver that amount of energy when it is brought to rest.

At Rjukanfos, Norway, three units of 14,500 horsepower capacity each have been furnished. Each unit has two wheels and each wheel two nozzles. The head is 250 meters (820 feet).

The buckets for these large wheels are of cast steel, hardened and ground. There were upon the floor stacks of rings having 22 such buckets some 22 inches long and 16 inches wide. With lower-pressure Francis wheels, 85 to 86 per cent. efficiencies are obtained; for the Pelton wheels with very high heads, 80 to 81 per cent. The impact wheel is not always used for high heads. We saw one of the Francis type designed for a head of 140 meters (460 feet) with phosphor-bronze runners and fixed walls for the water channels.

Development of the Blowoff Valve

By Charles J. Simeon

As the invention of the globe valve made the use of higher steam pressures possible it was at once tried for blowoff purposes. In its original form, though suitable for steam, it failed as a blowoff valve, but in a modified form became satisfactory. Its development is traced in this article.

As one of the requisites of a good valve for blowoff purposes is that the passage shall be direct and as free from obstructions as is consistent with right construction, it will be seen that the "Y"

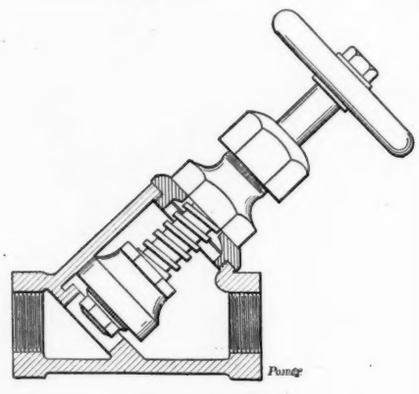


Fig. 1. Jenkins

type, though made in but few varieties, has much to commend it to the attention of the engineer.

In the design of all power-plant apparatus the aim has been to avoid complex construction and to make simplicity and directness the desired end. This practice has received especial attention in the matter of the design of piping and valves, particularly if connected with the blowoff, where restricted passages, short abrubt turns and pockets, or where solids or liquids are sure to be productive of annoyance, trouble and possible danger unless more than ordinary care is taken in operation. In many ways the necessity for a free unrestricted passage through

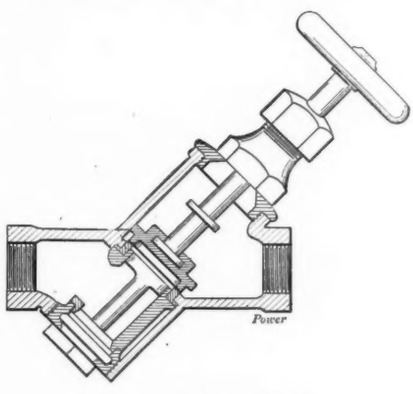


Fig. 2. Bashlin

the blowoff was demonstrated, and the designer readily adopted any idea that led toward the attainment of this feature.

Beside the cock several types of valves have been adapted to blowoff purposes. The first valve proper to be produced was the globe valve invented by Robert Briggs

in 1863. It was tried as a blowoff valve but was found unsuitable for this purpose owing to scale lodging round the seat and under the diaphragm. The "Y" valve was then tried and is by many considered satisfactory as a blowoff, particularly when combined with the special features of self-washing seats, renewable disks, etc. Besides the comparatively straight and clear passage, this type has the advantage of a seat at such a slant that it is difficult for scale to lodge thereon, and also a recess in the bonnet into which the valve is withdrawn in the open position out of the way of

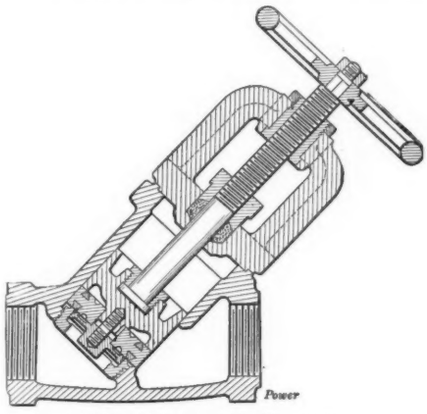


FIG. 3. LUNKENHEIMER

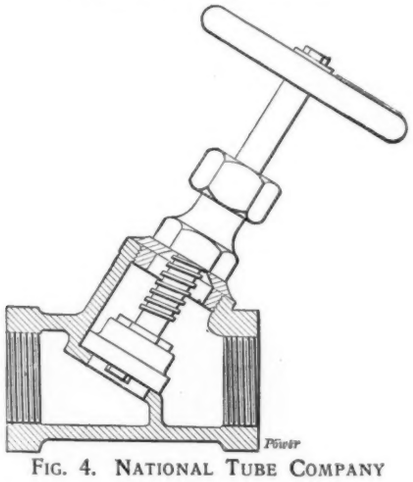


FIG. 4. NATIONAL TUBE COMPANY

the cutting action of the flow. Examples of this type of valve are the Jenkins, National Tube Company, Williams, Eynon-Evans, Powell, Bashlin and Lunkenheimer "Y" valves, each of which has special features of its own.

The Jenkins has a metal disk into which is set a ring of a composition that readily adapts itself to any irregularities in the seat or pieces of scale, etc., that may have lodged thereon.

The Bashlin has a hard gunmetal disk and a renewable seat whose special peculiarity is that it may be removed and renewed while under pressure. This is accomplished by carrying the seat on a hollow pillar, which may be removed through a hole in the bottom of the body, a flange on the disk furnishing a temporary seat, during its absence. The seat ring is made from copper for pressures above 125 pounds per square inch and of babbitt or asbesto-rubber for lower pressures. The Lunkenheimer company makes two patterns of this type. The regrinding pattern, which has a brass body, the diaphragm of which forms the seat, and a disk of bronze. The other pattern has

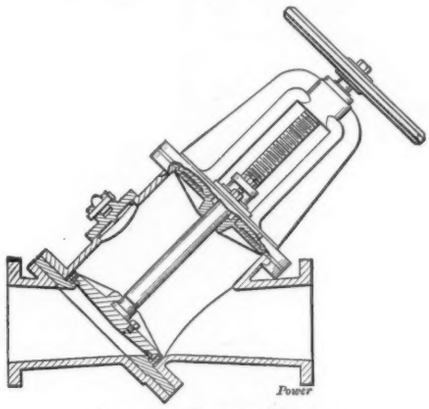


FIG. 5. EYNON-EVANS

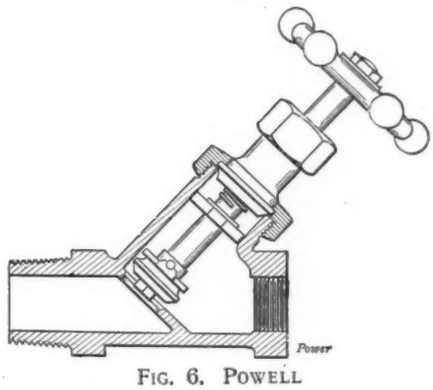


FIG. 6. POWELL

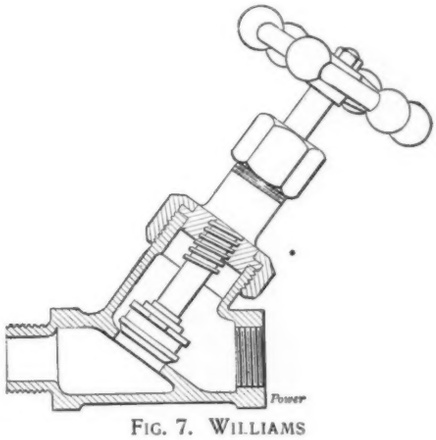


FIG. 7. WILLIAMS

a bronze seat ring screwed into an iron body, and a heavy reversible disk with babbitt-metal face rings. Both patterns have deeply recessed seats providing the self-cleaning feature.

Recognizing the simplicity, durability and nonleaking qualities of the plain slide valve under varying conditions of pressure, it was thought that a cover sliding freely over an orifice and forced to its seat when in position would closely, if not quite, approximate correct practice. The gate valve was the outcome of this line of thought and on their introduction into steam practice were at once tried for blowoff purposes on account of the obvious advantage of allowing a practically unobstructed passage when open. The Chapman is a good example. The Johnstone is a modification of the gate principle. It has a parallel-faced disk made of iron and loosely carried in a bronze stirrup. No spring or other mechanical means is used to keep the valve against the seat, the boiler pressure being relied upon to effect this. The seat consists of a cast-iron bush screwed into the body from the outlet side and is enlarged on the out-

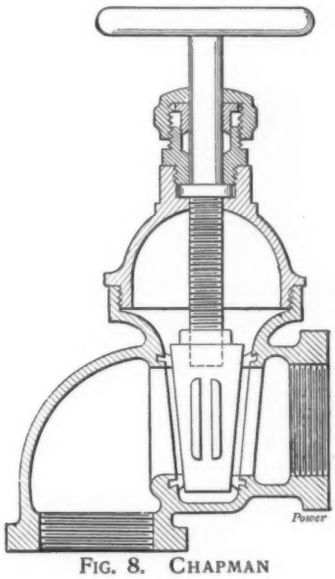


FIG. 8. CHAPMAN

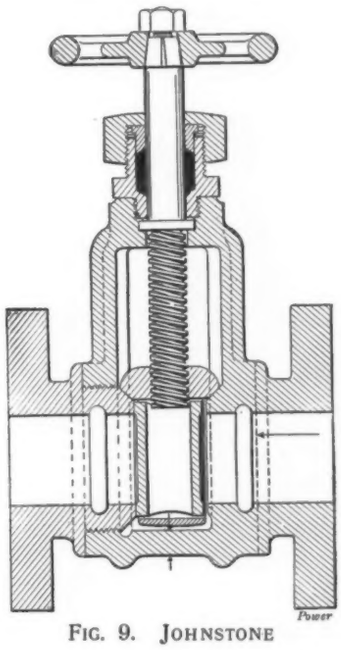


FIG. 9. JOHNSTONE

side for either flanged or screwed connection to the discharge pipe.

One objection to a gate valve for blowoff purposes is that the space below the disk is liable to fill with mud or scale and prevent it from closing.

The trouble of a gate valve not closing properly because of mud or scale lodging below the clapper has been guarded against in the Hestberg, in which

a door is provided in the bottom of the body, which may be opened while the valve is under pressure, and the accumulation of mud and scale removed. In the Watson & McDaniel Simplex, the disks are carried by a cage or stirrup which has a projection below it through which a hole is bored. When the valve is open, this projection completely fills the space occupied by the disk when closed, preventing sediment from lodging below the valve, while the hole allows a clear passage. The projection also forms a protection for the seat from the cutting action of the flow. Ease of manipulation together with tightness of the valve when closed are insured by using double disks separated by an internal wedge. The valve is operated by a key.

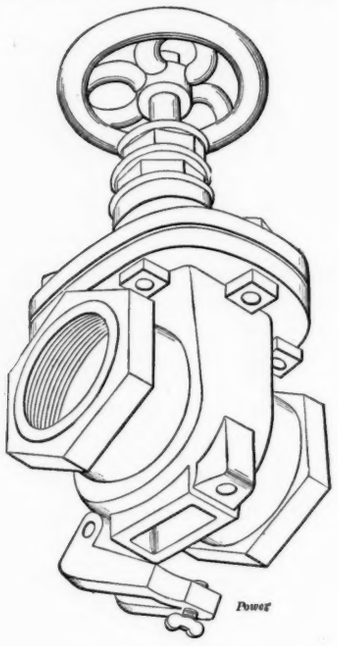


FIG. 10. HESTBERG

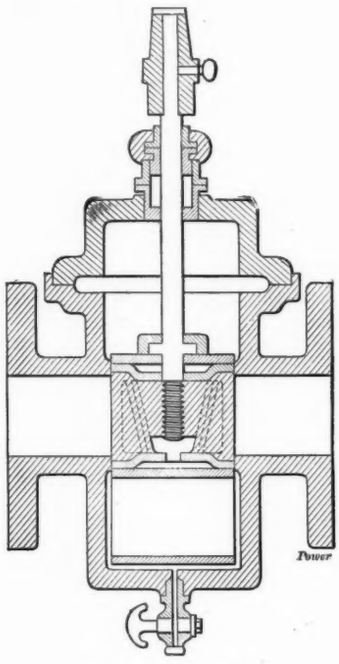


FIG. 11. SIMPLEX

The straight-way piston valve is a development of the gate valve. In it a piston or cylinder works in a cylindrical chamber, taking the place of the disk of the gate valve. The Star Brass blowoff has an expanding split cylinder, with a taper plug inside, that renders it easy to operate and insures a tight joint when closed. A plug in the body facilitates cleaning.

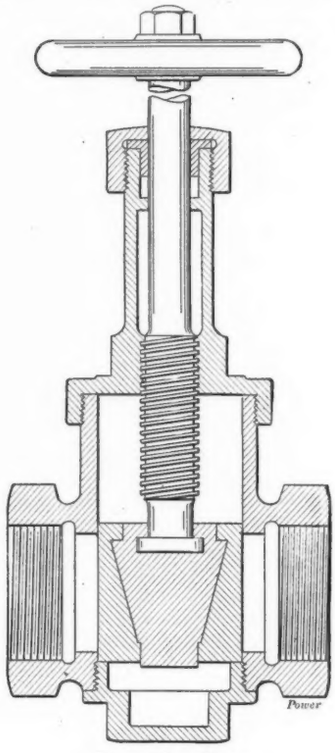


FIG. 12. STAR

The Absorption Refrigerating System

By F. E. Matthews

In which the various elements of the absorption system, such as the absorber, generator, analyzer, rectifier, etc., are described and the cycle through which the ammonia passes plainly illustrated.

A modern commercial absorption machine consists primarily of five parts, three of which are also present in the compression machine. This is shown in Fig. 1, which is a diagrammatic representation of an elementary absorption and compression machine having their condensers and complete expansion sides in common.

In the compression system it has been shown how the low-pressure cold gas returning from the expansion coils enters the suction end of the compressor cylinder, and how, after it has been transferred to the compression end of the cylinder, it is compressed and passed over into the condenser. Reference to the figure will show that in the absorption machine the compressor cylinder is replaced by an absorber, a liquid pump and a generator. In the absorption system the gas, returning from the expansion coils, enters the absorber, corresponding to the suction end of the compressor, is transferred to the generator, corresponding to the discharge end of the compressor, by a pump, through the valves of which it passes just as it flows through the valves of the compressor piston.

In the absorption plant the ammonia (liquor) pump can be made much smaller than the compressor gas pump used in the compression system, because the actual work of compressing the ammonia gas to the point at which it can be liquefied by the cooling water in the condenser is performed by the direct heat of steam rather than by the heat generated by the expenditure of energy behind the compressor piston. To facilitate the use of steam for this purpose, the cold ammonia gas returning from the expansion coils is absorbed or dissolved in water in the "absorber," and the resulting strong aqua ammonia, known as strong liquor, is pumped into the generator or ammonia boiler, where it is heated by a series of steam coils which drive off the gaseous ammonia at a high pressure, just as water vapor or steam is driven off under high pressure in a steam boiler.

The high-pressure ammonia gas driven off in the generator of an absorption plant, like that discharged from the compressor of a compression plant, is conducted to the condenser, at which point that part of the refrigerating cycle common to both systems begins.

The driving off of the ammonia vapor in the generator changes the strong liquor to weak liquor, which, being under a higher pressure than the liquid in the absorber, readily flows back to the absorber. To adapt the elementary absorption machine just described to the requirements of economical commercial apparatus, a number of refinements must be added. Fig. 2 is a diagrammatic representation of a modern absorption machine of well known make.

On account of the similarity of the expansion side of the absorption system to that of the compression system already described in detail, it will be nec-

essary to trace the working medium through only that part of the cycle between the expansion coils and the condenser.

Cooler

In the type of machine illustrated in Fig. 2, the expansion side consists of a brine cooler of the vertical cylindrical or shell type, such as is most commonly used in connection with absorption machines, but to some considerable extent with compression machines as well. The brine, usually calcium chloride, is circulated through nests of spiral coils within the cylindrical shell of the cooler, and the anhydrous ammonia is expanded into the space between the coils and the shell.

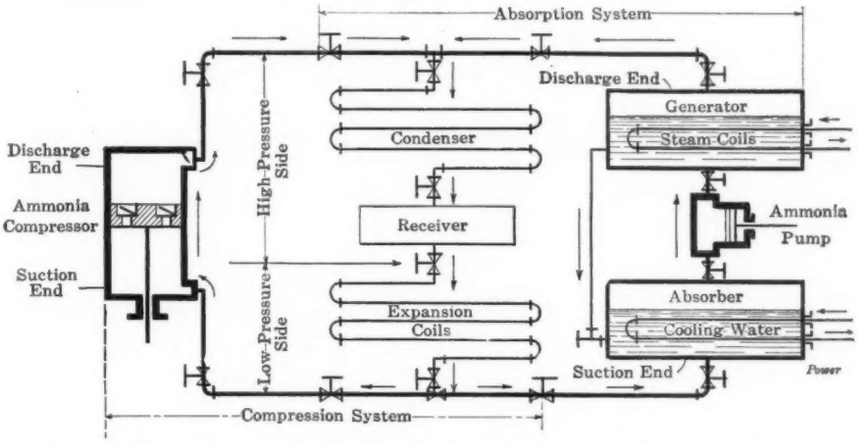


FIG. 1. DIAGRAMMATIC REPRESENTATION OF ELEMENTARY COMPRESSION AND ABSORPTION SYSTEMS

Absorber

In some cases the absorber is of the double-pipe type, similar to double-pipe condensers and brine coolers. The type here illustrated consists of a horizontal cylinder containing coils of pipe through which the cooling water which has previously done duty in the ammonia condenser passes. The cold, weak liquor is admitted at the top of the cylinder, passed down among the cooling coils, and there mingles with and absorbs the cold ammonia gas from the brine cooler.

As the cooling water has already been heated through several degrees in passing through the pipes of the ammonia condenser, it is expedient that a counter-current cooling effect may be carried out, in which the warmer, outgoing cooling water cools the weaker aqua ammonia, and the incoming cooler water is employed to reduce the temperature of the strong aqua ammonia on its way to the generator through the ammonia pump and exchanger.

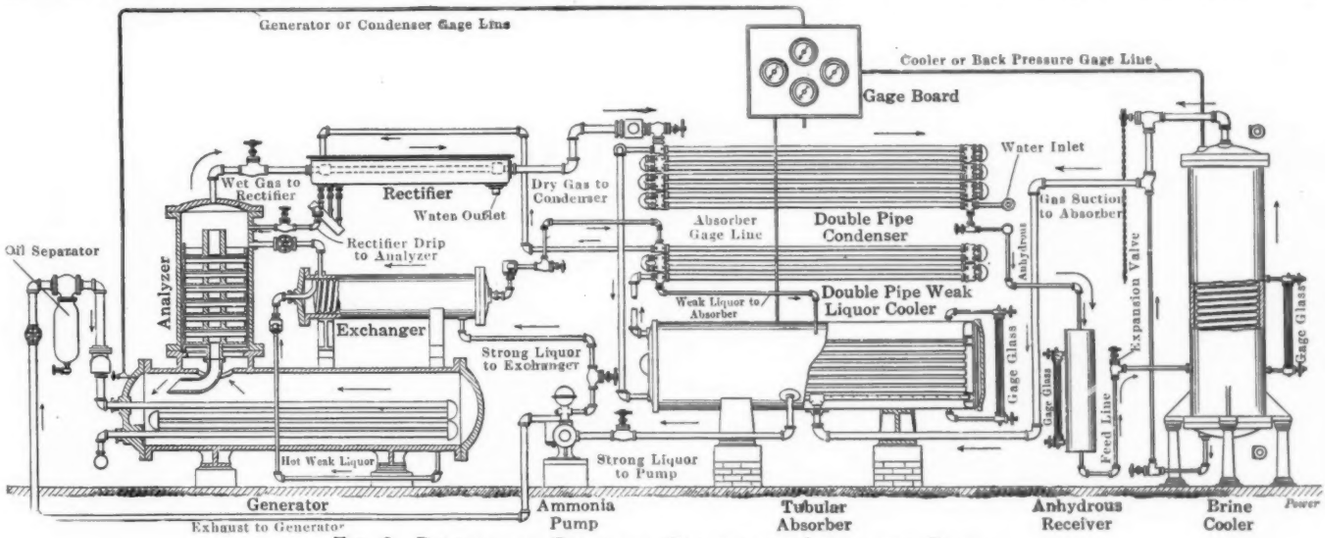


FIG. 2. DIAGRAM OF COMPLETE COMMERCIAL ABSORPTION SYSTEM

The amount of liquid present is readily observed by means of a gage glass. The cold ammonia vapor leaving the top of the cooler passes through the gas-suction line to the absorber, where it is joined by the weak liquor which has just undergone cooling in the "double-pipe weak-liquor cooler. Since the absorption of the ammonia gas into the weak liquor takes place with the evolution of a considerable amount of heat, further means for cooling the liquor must also be provided in the absorber.

Exchanger

The exchanger is a horizontal steel shell capable of carrying the full generator pressure through which the comparatively cool strong liquor is pumped on its way from the bottom of the absorber to the bottom of the generator. This rich liquor is shown entering the shell of the exchanger at the right-hand side, after which it traverses a spiral pipe coil and finally passes out into the top of the analyzer, shown just above the generator. The exchanger is provided with nests of pipe coils connected in parallel, through which passes the hot, weak aqua ammonia supplied to the manifold at the top of the exchanger by a pipe running to the bottom of the generator. In the countercurrent flow the hot weak liquor which must eventually be cooled in descending through the pipes gives up a part of its heat to the cooler rich liquor which must eventually be heated when ascending around the coils. By this heat exchange, cooling water is economized in the absorber and steam in the generator.

Analyzer

Leaving the top of the exchanger shell, the cool rich liquor passes to the top of the analyzer. Here it is allowed to trickle down over a set of metal trays, where, coming in contact with the ammonia vapors rising from the generator, the countercurrent heat-exchanging effect is still further continued. The hot ammonia vapor, entraining more or less aqueous vapor as it rises from the surface of the liquid in the generator, in passing up through the analyzer on its way to the condenser encounters the descending rain of cool rich liquor on its way to the generator. The former, which must eventually be liquefied in the condenser, is cooled, and the latter, which must eventually be boiled in the generator, is heated. This advantageous heat interchange also has the effect of actually condensing and returning to the generator a large percentage of the entrained aqueous vapors passing off with the ammonia, and also of liberating some ammonia gas through the heating of the

gas-saturated rich liquor; where ample analyzer capacities are employed, the incoming rich liquor should be within a very few degrees of the evaporating temperature by the time it finally reaches the surface of the boiling liquid.

Generator

The generator, or still, as it is frequently called, is the ammonia boiler for the evaporation of the weak liquor enriched and changed into strong liquor by the absorption of ammonia gas direct from the expansion coils, in the absorber. It consists of a substantial steel shell provided with a heavy cast-iron head through which pass the ends of the steam coils provided for supplying the heat required for driving off the ammonia. The strong aqua ammonia enters at the top, where it remains by virtue of its specific gravity being lower than that of the weaker liquor at the bottom of the generator. The water of condensation from the steam used in the generator is usually returned to the boilers. This can be effected either by an automatically controlled pump, or by a suitable high-pressure trap.

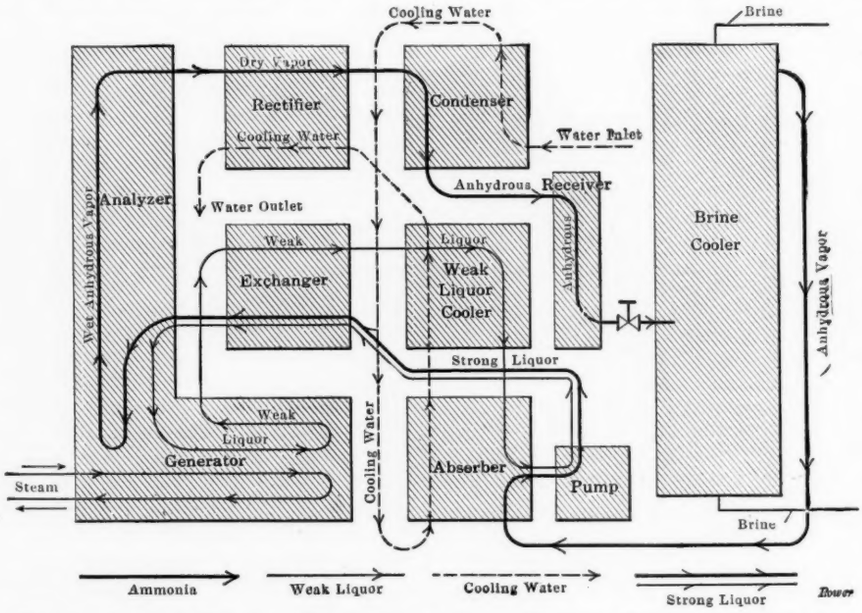


Fig. 3. Diagram Showing Paths of Ammonia, Cooling Water and Ammonia Liquor through Various Members of Absorption System

Rectifier

After leaving the analyzer, the hot ammonia gas passes to the rectifier, a water-cooled coil of pipes of sufficient area to insure the condensation of any aqueous vapors that may have escaped condensation in the analyzer. The liquid condensed in the rectifier is rich, saturated liquor which is returned to the generator by way of the analyzer.

Condenser

From the rectifier the ammonia gas, which should now be practically free from aqueous vapors, is passed to the condenser. Condensers for absorption machines like those for compression machines may be of either the atmospheric double-pipe or shell type as preferred. The anhydrous ammonia liquefied in the condenser passes to an anhydrous receiver, similar to those used in the compression system, from which it is drawn as required for expansion in the brine cooler, its flow through the feed line being regulated by the usual expansion valve. After evaporation in the brine cooler the ammonia gas again passes to the absorber, after which the working cycle is repeated.

Cycle Traversed by Ammonia

This can be readily traced by following the course of the heavy arrows in Fig. 2. The circuits of both the gaseous and the aqueous components of the aqua-ammonia refrigerant, as well as that of the cooling water, can be more readily followed out by means of the diagram, Fig. 3, in which all mechanical details have been omitted, and the several members of the refrigerating system illustrated in Fig. 2 are represented by shaded areas occupying approximately the same relative positions on the diagram. The path of the ammonia is represented by a heavy solid line; that of the water component of the aqua-ammonia refrigerant by a narrow solid line; and that of the cooling water by a broken line. The direction of travel in each case is indicated by arrows.

From this diagram as well as from Fig. 2, it will be seen that, as "anhydrous ammonia," the refrigerant starting from the "anhydrous receiver" passes to the "brine cooler," where in changing to the gaseous state it performs its sole function of absorbing heat from the brine. As saturated low-temperature ammonia vapor, the refrigerant starting from the brine cooler passes to the absorber, where it enters into solution or is absorbed by the weak liquor from the generator, forming strong liquor. As hot strong liquor the refrigerant starting from the absorber passes through the exchanger, where it gives up some of its heat to the weak liquor on its way to the absorber, then on by way of the analyzer into the generator, where the ammonia gas is driven out of the strong liquor solution, under high pressure, by the application of heat, and passes through the analyzer and rectifier into the condenser, leaving the impoverished aqua ammonia or weak liquor behind in the generator.

In the condenser, the heat originally absorbed by the anhydrous ammonia in changing from the liquid to the gaseous state in the brine cooler, as well as that added to increase its temperature and drive it out of solution in the generator, is given up to the cooling water, circulated through the condenser, causing the ammonia to return to the liquid state, after which it flows to the anhydrous receiver, and the cycle is again traversed.

The aqueous component of the aqua-ammonia refrigerant, starting from the bottom of the absorber in company with the ammonia in the form of strong liquor, passes through the exchanger and analyzer into the generator. Here it is separated from the greater part of the ammonia and returns through the exchanger and weak-liquor cooler to the absorber. Here it again joins the anhydrous ammonia, forming strong liquor, and retraces the path just described.

Path of Cooling Water

The cooling water is admitted first to the ammonia condenser, where it performs its most important function of removing heat from and liquefying the ammonia gas. After leaving the ammonia condenser it is still cool enough to be capable of absorbing a considerable amount of heat from the strong liquor in the absorber, more from the weak liquor fresh from the generator in the weak-liquor cooler, and still more from the hot ammonia gas fresh from the generator in the rectifier, after which it usually passes to waste.

Still another line might have been drawn on the diagram in Fig. 3, indicating the path traversed by the heat from the point of its absorption from the brine in the brine cooler to that of its expulsion with the cooling water from the condenser. Such a line, however, would coincide with that representing the ammonia from the point where the heat and the vapors of the refrigerant leave the brine cooler, continuing to the condenser, where it would cross over and join that representing the cooling water. It would then follow this line through its circuitous passage to the point where, together with the water, the heat flows away to the sewer.

It should be noted that throughout the entire system, a countercurrent effect is carried out between the cooling and the cooled substances.

By these countercurrent-cooling effects in which the coldest cooled substance gives up its heat to the coldest cooling substance, and the hottest cooled substance to the warmest cooling substance, the outgoing substance is cooled more nearly to the temperature of the incoming cooling substance than would otherwise be possible, thus effecting economy not only in the amount of the cooling substance required but also in the operation of the system through the reduction in the amount of the refrigerating medium required for a given amount of cooling.

A Boiler Explosion in Hungary

By S. Hurley

The accompanying photographs show two views taken immediately after a boiler explosion that recently occurred in the town of Szeged, Hungary, and which resulted in killing ten men and injuring fifteen more. The boiler that exploded was one of two employed in a match factory and was a water-tube boiler 3½ to 4 feet in diameter, made of ⅜-inch plate and normally carrying a gage pressure of 117 pounds per square inch. It was torn in three pieces which were thrown about the neighborhood by the force of the explosion. The front end was separated from the body and hurled across the adjacent street on to the roof of a house, and the rear end, weighing about 700 pounds, was shot up into the air about 60 yards, and fell into a military yard 250 yards distant. The middle section, or shell, was thrown across the street in the same direction with the front end, but landed in a vacant lot.

The force of the explosion was so great that the second boiler, which was exactly like its mate, was thrown bodily through the wall of the building out into the street, where it is shown in Fig. 1 with the wrecked boiler house. Fig. 2 shows the front end of the wrecked boiler lodged on the house top where it was thrown.

FIG. 1. THE BOILER HOUSE AFTER EXPLOSION OCCURRED

The cause of the disaster has not been very well established, but the boiler was evidently not in good condition, and a small rise in pressure was enough to rupture it. This was shown by the condition of the torn plate along the line where the end shown in Fig. 2 was separated from the main shell. Here the plate was transversely ruptured, just outside the row of rivets, for a distance of 18 inches, and along this entire break but 2 inches of sound metal was found. This would certainly indicate that the boiler was not in fit shape for use. Before the explosion occurred the engines were stopped to put on a belt and it is claimed that the accident was a result of the rise of pressure due to the closing of the throttle valves. This explanation would probably stand for some discussion because if the safety valve was working properly it should have taken care of any excessive increase of steam pressure. Any suggestions along this line by POWER readers would be appreciated.

In case of foaming, close the throttle long enough to show the true water level in the boiler. If the level is sufficiently high, feeding and blowing down will usually correct the evil. If foaming becomes violent, check the draft and use the surface blowoff freely. Ascertain the cause and take steps to prevent the evil.

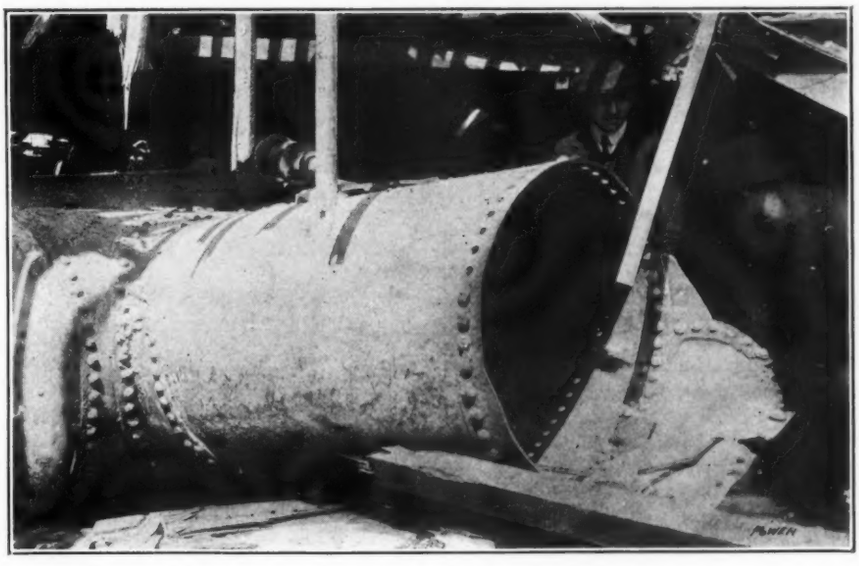


FIG. 2. FRONT END OF BOILER LODGED ON HOUSE TOP

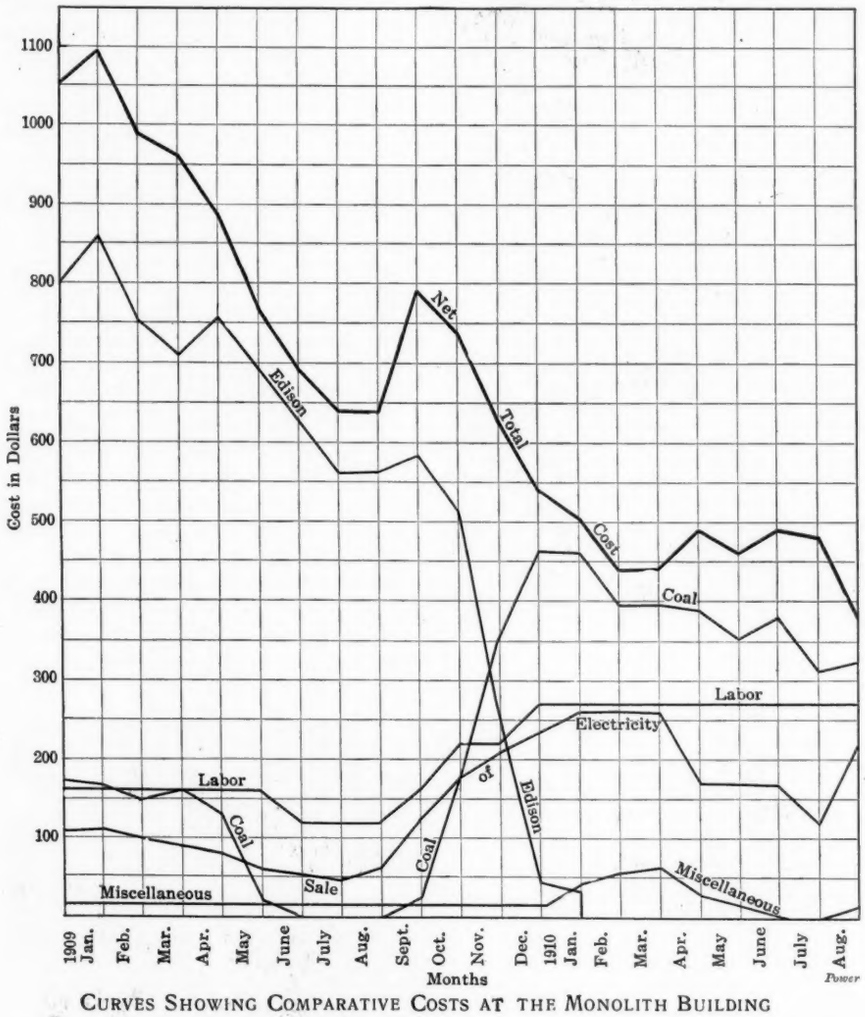
The Cost of Heat, Light and Power

By C. M. Ripley

By quoting the actual operating costs for heat, light and power, in a number of New York office buildings, apartment houses and hotels, the author is able to present a strong argument in favor of the isolated plant.

In the purchase of lamps, brooms, soap, labor, etc., the shrewd buyer is always prepared to prove that if he is paying more than the other fellow "per unit," he nevertheless is paying less "per year." A discussion of unit costs of heat, light and power is still more misleading unless further evidence is provided regarding total yearly costs. In buildings containing independent electric plants, these items are so closely intertwined that the total yearly cost is the final test.

In the following discussion the total yearly operating cost is given for heat, light, power and engineers' services for repairs, etc., in a number of buildings in New York City, which information has come first hand and is authentic. The term "cost of electric plant" refers to the extra engineering investment in excess of the cost of a heating plant only. Depreciation is figured at 5 per cent. and interest at 5 per cent. on the original investment.



CURVES SHOWING COMPARATIVE COSTS AT THE MONOLITH BUILDING

OFFICE BUILDINGS

The Terminal building, at Park avenue and Forty-first street, is twelve stories high and contains an electric plant which cost $12,000. This building was formerly on Edison service. During the past year all the offices and stores have been rented and the electrical output has increased to an annual total of 156,340 kilowatt-hours. From October, 1909, to June, 1910, inclusive, 125,430 kilowatt-hours were produced with a total fuel bill of $2528. During the preceding period from October, 1908, to June, 1909, inclusive, the electrical output was only 91,770 kilowatt-hours and the coal bill was $2145. This shows what effect the filling of the building had upon the operating costs, the increased output of 33,660 kilowatt-hours costing only $383 in coal, as the fixed charges remained the same.

Following is the summary of the operating costs for light, heat and power during the past twelve months:

Screenings @ $2.22 per ton	$3098
Wages	3217
Water for boiler	100
Repairs, oil, ash removal and miscellaneous (not including lamps)	851
Total	$ 7266
Less sale of electricity	400
	$ 6866
Ten per cent. charges against plant	1200
Net total cost	$ 8066

Had the electricity been purchased from an outside source and the heat been produced on the premises, and men employed for repairs, etc., the cost would have been as follows:

No. 1 buckwheat coal, @ $3.35 per ton	$ 2,000
Fireman, eight months	400
Engineer and building manager	1,500
Electricity, 156,340 kilowatt-hours @ 5c. per kilowatt-hour	7,817
Care of elevators and repairs to heating system, plumbing and wiring	300
Oil and grease	50
Total estimated cost	$12,067
Less sale of electricity	400
Net total cost	$11,667

This shows a saving of $3601 attributable to the independent electric plant, which means that the plant will pay for itself in about three years. It means that a capital of $12,000 is invested and earns $3600 a year, or 30 per cent. per annum; and this, after paying 5 per cent. interest on itself and 5 per cent. for depreciation.

The curves in Fig. 1 show the operating costs for the past twenty months at the Monolith building. Three different kinds of operation are shown during this period. From December, 1908, to October, 1909, the building was on Edison service exclusively. From October, 1909, to January, 1910, they were using some Edison and some of their own electricity. During the remainder of the time they were using their own electricity, exclusively. The heavy black line at the top represents the total net cost, and it is obtained by adding all operating expenses for the period and subtracting therefrom the entire income from the sale of electricity to tenants and neighbors. It is this difference month by month that locates the points on this curve. The curves show the variations in the different items of expense, month by month, and that a net saving on the manager's books of between $450 and $600 per month has been effected. The itemized costs of the main part of the electric plant are as follows:

Three Ridgway engines and dynamos	$5500
Switchboard	927
Storage battery	3000
Electric meters	352
Total	$9779

On lower Broadway, there is an office building twelve stories high and covering

*From an address to be delivered before the Blue Room Engineering Society of Greater New York on October 29.

an area of 50x150 feet, which is equipped with an electric plant delivering 117,235 kilowatt-hours per year, although the building is only about half rented. Of this amount, 38,755 kilowatt-hours are for power and 78,480 kilowatt-hours for light. The first cost of the entire engineering equipment of the building was,

Three Ames engines	$4 770
Three dynamos	3,600
Wiring of entire building	7,100
Boilers and piping for the entire building	20,400
Storage battery	3,000
Switchboard	1,600
All mason work	2,000
Stack	1,100

The operating costs per year are,

No. 1 buckwheat coal, @ $3.35 per ton	$2,214
Labor	3,329
Miscellaneous, including lamps	1,598
	$7,141
Receipts from tenants for electricity	1,710
	$5,431
Fixed charges, 10 per cent. of plant cost	1,400
Total net yearly cost	$6,831

At the market rate of 5 cents per kilowatt-hour, the electricity alone is worth

$$117{,}235 \times \$0.05 = \$5862.$$

Coal and labor for heating would easily amount to $2400 more and a skilled engineer is necessary to repair elevators, etc., whether electricity is made or bought. Therefore, this plant is already saving almost $3000 per year, and when the building is fully rented the power plant will make a record to be proud of.

The Security Mutual Life Insurance Company's building, at Binghamton, N. Y., contains two hydraulic elevators and an electric plant which delivers 340,000 kilowatt-hours per year. The costs for the year's run during 1909 were as follows:

No. 1 buckwheat coal @ $3 per ton	$4062
Wages	3208
Miscellaneous	800
	$8070
Sale of electricity	600
	$7470
Ten per cent. fixed charges	1500
Total operating cost	$8970

It is estimated by the consulting engineer that it would cost $3200 per year in coal and labor to run this building in case electricity were purchased from an outside source. If this estimate is correct, the 340,000 kilowatt-hours are generated at a cost of 1.6 cents per kilowatt-hour.

In New York City there is an office building partly occupied by the owners, who are publishers of an evening newspaper. This building uses less electricity than the Security Mutual Life Insurance building, and yet it pays $12,000 per year for electricity alone—quite a contrast to less than $9000 per year for heat, repairs and electricity, including fixed charges, which is the expense at the former building.

The total comparative costs are as follows:

New York newspaper building, for heat and electricity per year	$23,000
Security Mutual Life building, gross cost heat and more electricity per year	9,570
Difference	$13,430

It should be remarked, however, that in the case of the former the labor charges are high because of the newspaper-union conditions; also the New York building has a greater number of hydraulic elevators. Yet, when considering the cost of electricity alone in the New York building it will be found to be greater by 25 per cent. than the cost of heat, light and power at Binghamton; hence the labor and coal prices are not large factors.

Loft Buildings for Light Manufacturing

The Langedorf building is twelve stories high and occupies a plot 100x100 feet. The building originally had Edison service. A plant was designed consisting of two units, only one of which was installed at first to demonstrate the facts. The original installation, with provisions for the additional unit, cost about $8300 and consisted of a Corliss engine belted to a 125-kilowatt dynamo. Blowers were installed to facilitate the burning of refuse and sawdust from the wood-working plant. From July, 1909, to June, 1910, the cost of heat, light and power was as follows:

Screenings @ $2.22 per ton	$3178
Labor	2929
Ash removal, repairs and miscellaneous	950
Water from deep wells	000
	$7057
Less sale of electricity	2855
	$4202
Ten per cent. charges on equipment	830
Total net cost	$5032

This represents the cost of producing 180,910 kilowatt-hours, heating the building, furnishing live steam, repairing elevators, repairing the plant, cost of oil and miscellaneous, but not including lamps.

The following is the estimated yearly cost if electricity had been purchased:

No. 1 buckwheat coal @ $3.35 per ton for heat, hot water and live steam	$ 1,550
Chief engineer and superintendent	1,200
Fireman	660
Edison electricity, 180,910 kilowatt-hours @ 5 cents per kilowatt-hour	9,045
Care of elevators, repairs, oil and grease	350
Total	$12,805
Less sale of electricity	2,835
Net total cost if buying electricity	$ 9,970
Actual total cost when generating electricity	5,032
Difference in favor of generating electricity	$ 4,938

Here is an $8300 investment saving $4900 per year, or nearly 60 per cent. after it has saved money enough to pay interest on itself and 5 per cent. depreciation.

Late this past summer authorization was given for the completion of the plant with the addition of a 150-horsepower Brownell engine and an 80-kilowatt dynamo. These will cost approximately $2800 and are to be kept in reserve for an emergency. This building is a typical New York City loft building and contains a complete printing establishment, making a specialty of night work and delivering on the judge's desk at 9 a.m. the complete testimony and court proceedings of the day before. It also contains wood-working machines, buffing machines, hot tables and glue pots requiring live steam.

A nine-story loft building at 213 Grand street has two elevators and a small electric plant, the cost of the equipment being as follows:

Electric wiring for entire building	$ 850
One Ridgway engine	1435
One 75 kilowatt Sprague dynamo	1182
One 125-horsepower Titusville boiler	875
Steamfitting, including pumps, radiators, etc.	4950
Meters and later installations	213

This plant began operating last February and up to September 1, 1910, during part of which time the building was only partly rented, the operating costs were as follows:

Screenings @ $2.06 per ton	$ 596
Labor (the engine-room force operates one elevator)	879
Edison service	150
Repairs, ash removal, water and miscellaneous	450
	$2075
Ten per cent. charges on equipment	500
Total cost	$2575

During this time the receipts from tenants were $2803, including two tenants who purchase live steam the entire year at $160 per year. Therefore, the net operating cost for the first seven months has not only been a negative quantity for furnishing heat, hot water, public lights and electric power for pumping and for two elevators, but has actually shown a profit of several hundred dollars. As the electric output increases, this record should become even more favorable.

The Weil & Mayer buildings, at 580-590 Broadway, consist of three twelve-story loft buildings containing a total of seventeen electric elevators. The record of these buildings illustrates the advantage of supplying neighboring customers with heat, light, power and hot water. The actual cost of producing heat, light, power and live steam for twelve months were as follows:

Screenings @ $2.50 per ton	$ 6,830
Wages	8,617
Water for boilers from deep wells	000
Repairs, ash removal, oil, miscellaneous	1,881
	$17,328
Less sale of electricity	13,336
	$ 3,992
Ten per cent. charges against plant	2,000
Net total cost	$ 5,992

This amounts to but little over $150 a month for each building for complete service of heat, light and power for pumping and elevators. The electrical output for the year was 402,000 kilowatt-hours. The following figures are a fair estimate of the cost of heat, light and power had the buildings been operated together and electricity bought from an outside source:

402,000 kilowatt-hours	$18,780
No. 1 buckwheat coal @ $3.35 per ton for heat and live steam	4,500
Wages, including fireman	4,100
Oil, grease, ash removal, repairs, miscellaneous	1,000
Total	$28,380
Less sale of electricity	13,336
Net operating cost when buying electricity	$15,044
Actual net operating cost when producing own electricity	5,992
Saving by producing own electricity	$ 9,052

If the three buildings had been operated separately, the following estimate would have applied:

No. 1 buckwheat coal @ $3.35 per ton for each building	$ 1,500
Wages, including fireman	1,800
Electricity for each building	6,700
Repairs, oil, etc	400
Total for each building	$10,400
Total for three buildings	31,200
Less sale of electricity	13,336
Net total cost for three buildings operated separately, if buying electricity	$17,864
Actual net total cost producing electricity and operating together	5,992
Saving by operating buildings together and producing own electricity	$11,872

The conclusion to be drawn from these figures is that by operating the three buildings together $2820 is saved yearly, and by producing their own electricity an additional yearly saving of $9052 is effected. The saving of $9052 is equivalent to the annual income on a capital of $180,000 invested at 5 per cent., yet the actual cost of the plant was only $20,000; and being installed twelve years ago it paid for itself in two and a half years. Also, the annual earning power of the plant is about 45 per cent. per annum on the investment.

These records show that the first investment was paid back, in savings effected, nearly ten years ago, and yet in order to be perfectly fair I am still charging against the record of the plant 5 per cent. interest on the investment. Furthermore, although the plant has paid for itself many times over, I still charge against the record of the plant another 5 per cent. for depreciation. The plant is in excellent condition today after twelve years of service and will probably last another ten years.

Apartment Houses

The Hendrik Hudson apartment house on Riverside drive is nine stories high and contains seventy apartments. Being 200 feet on the side facing the river it is exposed to the cold winds from that direction. The boilers are used for heating and in the coldest days for pumping also. All the electricity is furnished by the New York Edison Company.

It has been found that central-station electric service is more profitable in a medium-sized apartment house without a refrigerating plant than in any other type of building in New York City, except the theater. This is because the cost of operating the plant to provide a 24-hour service is high and yet the consumption of electricity is much smaller than in an office building of the same size with a 12-hour service. Also, the consumption is much less than in a hotel of the same size, as is also the elevator travel. In an apartment house the income for light, etc., from the tenants is almost negligible during the summer months where the tenants go away for the summer.

From August, 1909, to July, 1910, the operating costs at the Hendrik Hudson were:

Screenings @ $1.98 per ton	$ 2,185
Wages	2,233
Edison service	5,105
Miscellaneous, including lamps	1,149
Total operating expense	$10,672
Less sale of electricity	4,059
Total net operating expenses	$ 6,613

The total consumption of electricity was 102,103 kilowatt-hours. It is necessary to use 100,000 kilowatt-hours per annum in order to obtain the 5-cent rate in New York, and the custom is to sell to the tenants at 10 cents per kilowatt-hour. In winter the pumping is done largely by steam, the pressure being kept at about 60 pounds. The exhaust is used to help heat the building besides furnishing hot water for about one hundred and fifty bath rooms. The fuel costs $1.98 per ton and in addition the garbage and refuse are burned under the boilers.

Hotels

The Hotel Hargrave covers an area 50x200 feet, is twelve stories high and contains three hundred guest rooms, two hundred baths, a restaurant, four electric elevators and complete ice and electric plants, but no laundry. Being a hotel, there is a 24-hour service. The electric plant, including a storage battery, cost $13,063. The operating costs for the past year were:

Screenings @ $2.22 per ton	$ 6,237
Wages	4,895
Boiler water (estimated)	150
Ash removal	120
Repairs, oil, lamps and miscellaneous	1,400
Total	$12,802
Ten per cent. charges against plant	1,306
Total net operating cost	$14,108

This is the cost of producing 289,877 kilowatt-hours of electricity, ice, refrigeration, heat and hot water.

The estimated cost of running this hotel in case electricity were purchased from an outside source is as follows:

Edison service, 289,877 kilowatt-hours @ 5 and 4½ cents per kilowatt-hour	$13,944
No. 1 buckwheat coal @ $3.35 per ton for heat, ice and hot water	4,500
Wages	3,480
Repairs, ash removal, oil, water, etc	600
Total net operating cost if buying electricity	$22,524
Net total cost when making own electricity	14,108
Saving by making own electricity	$ 8,416

Thus the plant paid for itself in less than two years, or looking at it in another way, it pays 65 per cent. per annum on the investment.

It happens that when this hotel was half its present size it did not have any electric plant, and our office is in possession of the records of operating expense for the ice and heating plant before it was supplemented by the electric plant. It is from these records that I estimate the cost of the ice, heating and hot-water service.

Increased Income from Engine Rooms

In New York City in the past it has been difficult for the owners of one building to sell electricity to their neighbors, on account of the threatened classification of the building as a central station by the insurance companies and the resulting increase in insurance rates. For instance, two buildings located side by side and separated by a party wall were owned by one man. An electric plant was installed in one building from which both buildings were supplied with heat, light, power and hot water. Later, one of the buildings was sold, and just because the title had changed hands, a move was made to increase the insurance rates on the presumption that the fire hazard had been increased.

Besides selling electricity to the tenants, a Broadway apartment house with an electric plant is getting $1800 per year by selling exhaust steam to a neighboring building. Another apartment house on Park avenue is heating every house on the block and deriving a good profit.

It is easy to add a few thousand dollars to the annual income of a building if it has an independent electric plant. If it is thought that the engine, dynamo or boiler capacity is not large enough to do this, tungsten lamps may be installed throughout, and the facilities thereby almost trebled. Tungsten lamps are a good investment in almost any building, especially if they are rated three or four volts higher than the actual voltage.

The United States Geological Survey, at Washington, has been testing fuels for several years and will gladly send its literature upon request. The gist of the report for the building manager is the conclusion stated by a Government engineer: "Not always, but generally, the cheapest coal to buy in any locality is the lowest-priced one, provided conditions in the plant will permit its use." The report shows that for almost any character of coal, old furnaces may be adapted, or new ones designed, which will burn such fuel with reasonable efficiency, and that practically no fuel should be rejected as worthless. The post-office department, some hotels, hospitals, apartments and office buildings have been using screenings with considerable economy, although there are many theoretical objections to the use of such fuels.

Electric Pumps versus Steam Pumps for Hydraulic-elevator Service

At the Security Mutual Life Insurance Company's building, in Binghamton, a series of four different tests was run upon the elevators. One week the electric-elevator pump was used and the next week the steam-elevator pump. The coal consumption, electrical output and number of elevator trips were carefully noted. The following data give in brief the result of a typical test run for two five-day periods:

	Electric Pumps.	Steam Pumps.
Coal burned, tons	17.3	20
Number of elevator trips	3937	3363
Kilowatt-hours of electricity	4780	3230

This shows that 18 per cent. more service was delivered with 16 per cent. less fuel when electric pumps were used. With coal at $3 per ton, the electric pumps saved $8.10 during the five days' test, but if the additional 1550 kilowatt-hours required to run these pumps had been bought from an electric company at 5 cents per kilowatt-hour, it would have cost $77.50. Or, if bought as low as 3 cents per kilowatt-hour the electricity would have cost $43.50, entirely wiping out the saving of $8.10 in fuel which the electric pumping effected.

Present Practice in Elevators

For a building higher than twenty-five stories—the traction type of electric elevators.

For the greatest degree of safety—the hydraulic-plunger elevator.

For the greatest competition and lowest first cost—the electric elevator.

For the lowest repair expenses—the hydraulic elevator.

For the most flexible equipment—the electric elevator, as it can use central-station or isolated-plant electricity, if designed intelligently.

For the engine-room crew with the least experience in elevators—the plunger elevator.

For the lowest operating cost in most buildings—the electric elevator.

For the least amount of machinery in the basement—the overhead electric elevator.

For the lowest operating cost where the elevator travel is small—the electric elevator.

For the most popular elevator, with largest sales—the electric elevator.

For a building later to be increased in hight—the traction type of electric elevator.

For the elevator with the least bounce in stopping—the electric traction elevator.

For a six-story apartment covering an area of 100x100 feet—one electric elevator at a speed of 250 feet per minute.

For a twelve-story apartment covering an area of 100x100 feet—two electric elevators at 250 to 300 feet per minute.

For a twelve-story hotel covering an area of 100x100 feet—one freight and two passenger electric elevators at 300 feet per minute.

For a twelve-story office building covering an area of 100x100 feet—one passenger electric elevator at 350 to 400 feet per minute.

For a twelve-story loft building covering an area of 100x100 feet for light manufacturing—two freight and two passenger electric elevators.

For a six-story apartment covering an area of 100x100 feet—an electrical consumption of 350 to 400 kilowatt-hours per month.

For a twelve-story apartment (any size)—an electrical consumption of 750 kilowatt-hours per year per apartment.

For a twelve-story apartment hotel covering an area of 60x100 feet—an electrical consumption of 3300 kilowatt-hours per month.

For a twelve-story office building covering an area of 100x100 feet—66,000 kilowatt-hours per year—three elevators.

For a twelve-story loft building covering an area of 100x100 feet—an electrical consumption of 500 to 750 kilowatt-hours per month for each elevator.

Cause of Variations in Cost

If an engineer is told that a neighboring building, similar in size and character, is spending only $10,000 per year for light, heat and power, while the expenses of his plant are $15,000 per year, nine times out of ten he will reply that "Conditions there are different." This may be true, perhaps, but not the whole truth. Then if the engineer of the neighboring building is asked how it is that his plant only costs $10,000 per year for light, heat and power, whereas the first building costs $15,000, he will probably answer, "I know my business and prevent waste." This, again, while true, is not the whole truth. The point I wish to emphasize is that the operating engineers as a class shift all the blame for a bad operating record and claim all the credit for a good operating record. The only way for building managers to decide whether the operating man is at fault or not, is to delve into old records of coal bills. If it is found that during some preceding year when the building was practically full the coal bill was 20 per cent. less and the price of coal practically the same, with no mitigating circumstances such as a very mild winter, the later addition of an ice plant, another elevator, a vacuum-sweeping installation or the construction of a large building on either side, then the manager may be sure that it is time to make a change. It is time for him to get a new engineer and pay him $20 more per month and change to another coal dealer. Or better yet, give the new engineer 10 or 20 per cent. of what he saves. Then, for every dollar's worth that he expends he feels that he is taking 10 or 20 cents out of his own pocket.

On the other hand, if the coal bill has not increased a substantial amount over past years, one may be sure that the reason for the high cost is not to be laid at the door of the operating engineer, but antedates the time at which he was hired. In this case it may be attributed to an error in the design of the plant. As the chief engineer of the great Metropolitan building, Mr. Bavier, said: "Anyone taking over a new building is like a man adopting a child; someone else created it and hereditary weaknesses on the part of the child must not be charged against the new parent who adopted it." Nor should errors in the design of the engineering equipment be charged against the building manager, for he is only too often doing the best he can with what someone else provided. Too many times that someone else is a man who has his mind intent, first, on landing a contract; second, on cutting down installation cost, and third, on (perhaps) the reduction of operating expenses and repairs in the future. The engineering salesman gets paid for new business and not for saving money in the basement ten or twenty years after the job is landed.

Packing and Junk Rings

By W. J. Barker

Fig. 1 represents the section of a cast-iron junk ring lined with Allen's red metal. The latter projects ⅛ inch beyond the cast iron and is 2⅛ inches wide. From past experience I can say that low-pressure junk rings made up in this way will last from five to six years before it is necessary to renew the red metal.

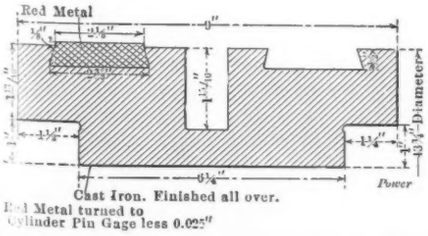


Fig. 1. Section of Low-pressure Junk Ring

Fig. 2 shows half of a 44-inch cast-iron packing ring. The ring is narrow and deep and has a good bearing on the sides of the groove which helps to keep the ring from rocking. It is held against the walls of the cylinder by flat steel springs ⅛ inch thick and the width of the groove. These springs are hinged on the ring in the recesses made for this purpose and are self-adjusting.

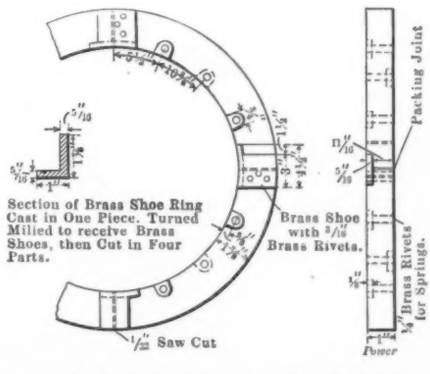

Section of Brass Shoe Ring Cast in One Piece. Turned Milled to receive Brass Shoes, then Cut in Four Parts.
Brass Shoe with Brass Rivets.
Saw Cut
Packing Joint
Brass Rivets for Springs.
Power

Fig. 2. Low-pressure Packing Ring

Significant Figures for Engineers

By H. J. Macintire

Practical examples which show the uselessness of carrying mathematical calculations to extremes when the factors involved con ain error.

How many figures should be retained in the answer of an engineering problem? This matter is very confusing unless some idea of significant figures is understood.

A digit is any figure from 1 to 9 inclusive. A significant figure is any digit which is employed to signify the amount of the quantity to be used. The zero is, therefore, as important as any of the digits and should be retained if the work warrants it. For instance, suppose a measurement to be made and that it is found to be 451.10 inches. The measurement is one that can be made to 1/100 of an inch, and if the final zero were dropped, making the measurement 451.1 inches, it would not be known how accurately the work had been done, as it would seem that the measurement had been made only to 1/10 of an inch. When it is necessary to reject figures, the last one of those retained should be increased by one, if the next digit is over five. If an answer came out 387.567 and the required accuracy warranted retaining only four figures, the answer would be 387.6 instead of 387.5.

In a long calculation there will be a series of errors or approximations, and the answer would have some figures which would be correct and others which would be of doubtful exactness. If only the correct ones were retained, and *one* place of the approximate figures, the average of the observations would be still doubtful as to the last figure. On the other hand, if two doubtful figures were retained, the accuracy of the second last would be reasonably sure. As an example of this, take the case of the value of the circumference of a circle divided by the diameter. Suppose the determination were made a number of times, say six or seven, and then the results averaged. It is supposed that some method of measuring both the circumference and the diameter was employed and that the following figures represent the results of dividing the values obtained for the circumference by those obtained for the diameter:

$$\begin{array}{r} 3.1412 \\ 3.1420 \\ 3.1417 \\ 3.1411 \\ 3.1419 \\ 3.1413 \\ \hline 6)\,18.8492 \\ \hline 3.1415333+ \end{array}$$

In the above, one may be absolutely sure of the first *three* figures, the last two being doubtful. In averaging it was necessary to retain the two doubtful ones or be uncertain of the reliability of the fourth figure in the answer. The answer should be 3.14153, every figure of which it is perfectly legitimate to retain. The last figure is, of course, very doubtful. The rule to be followed is then:

(1) *In data to be averaged, retain two places of unreliable figures. The average may contain one additional figure.*

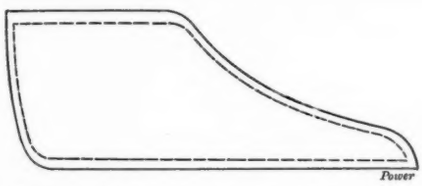
Suppose that an engine test was being figured with the following data:

$P = 53.4$ pounds per square inch;
$L = 12$ inches;
$A = 113.1$ square inches;
$N = 200$ strokes per minute;

$$H.P. = \frac{PLAN}{33{,}000} = \frac{53.4 \times 12 \times 113.1 \times 200}{33{,}000 \times 12}$$

$$= 36.6033$$

The question arises, how many figures should be retained in the numerator and the answer? Consider the factors of the numerator. The stroke can be measured



ERROR IN DIAGRAM DUE TO BACKLASH

to 1/100 of an inch, also the diameter. The precision here is within one in

$$100 \times 12 = 1200$$

or 1/12 of 1 per cent. It is assumed that the revolutions per minute are ascertained with an ordinary counter, and a precision of only one in 200 or ½ of 1 per cent. can be assumed. When it comes to the mean effective pressure it is much different, for a number of things unite to make the possible error great. First, the reducing motion is a variable quantity; it may give anything from a very bad to an exact reproduction of the motion of the piston. Then if the indicator is some distance away from the reducing motion, requiring a long length of cord, there is sure to be a stretch to it unless soft piano wire is used or something equally as good. Backlash in the pantograph of the indicator will give a diagram as shown herewith, which is smaller than the correct diagram, and finally, but least by no means, the indicator may be incorrect. To be sure, the indicator should be calibrated before and after the test, and an average calibration taken. As a rule a 2-pound error in an 80-pound spring is not unusual for a good spring, or a 4- or 5-pound error for a spring that has had considerable use. Assuming that it is impracticable to calibrate the instrument and the error, as is usually the case, is unknown, a variation of two pounds in the spring may be assumed. Such an error in an 80-pound spring is 2½ per cent. or in this factor the test is in error 2½ per cent. Therefore, there is a doubt to the extent of 2½ per cent. of 36.60 or 0.9 horsepower. The answer as regards the first digit is right, but there is doubt of the second; hence, the answer should be 36.6 horsepower. More figures would be absurd and useless.

(2) *In multiplying and dividing the least reliable factor should be determined first. Find its precision and retain only enough figures in the answer to give the same precision.*

Certain errors, although great at first, if the test is continued for a comparatively long time, will become very much smaller in the total percentage error. Take, for example, the boiler test where the hight of the fire or the grate is estimated before and after the test. The possible error is about 2 inches in getting the hight of the fire. The entire error would be,

$$\frac{2 \times \textit{grate area}}{12}$$

cubic feet of coal at 60 pounds per cubic foot. For a short run, or in one using a small amount of coal, the error would be great, but if the amount of coal used were large, the resulting percentage error would be inappreciable. Errors in the weights of the coal and the water, however, are accumulative, for if the scales are out of order and only weigh within a few pounds in 500, the error will be just as great a percentage at the end as at first. The kind of measurement, and the length of the time of the test, therefore, affect the precision and the answer.

The following is a good example of a perfect disregard of significant figures taken in detail from a well known handbook. The data are of a boiler test:

Heat of feed water, 79 B.t.u.
Total heat imparted to each pound of steam, 1189.34 — 79 = 1110.34 B.t.u.
Total weight steam and water passing through engine, 216,492 pounds.
Total amount of heat given to engine = 216,492 × 1110.34 = 240,379,727.28 B.t.u.

Granted that the total heat of steam is accurate to 1/200 of 1 per cent., which it is not, and that the water could be weighed to one pound in 5000 pounds, how many figures should there be in the answer? The least precision here is one in 5000 and, therefore, the answer cannot possibly be more precise. The answer should be 24,380,000 B.t.u.

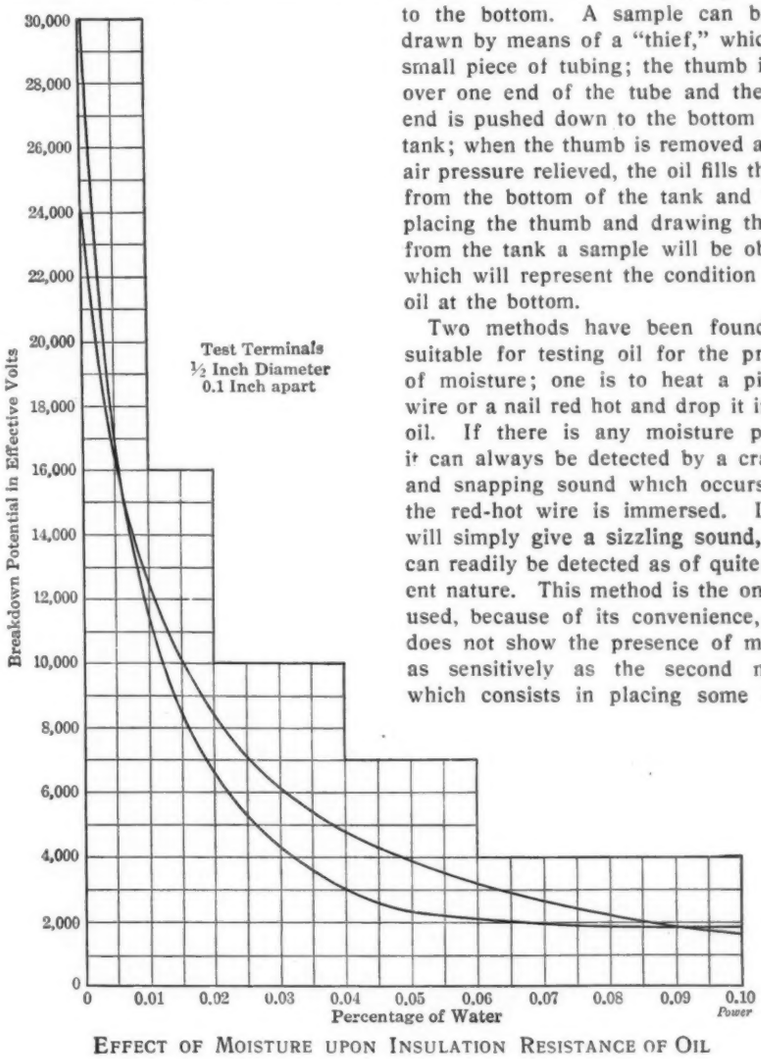
Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Moisture and Impurities in Transformer Oil

By J. Vincent Hunter

In a previous article* I pointed out the importance of keeping transformer and switch-tank oil (commonly called "transil" oil) free from moisture, because of the rapid decrease in insulating quality that is produced by even minute additions of water to the oil. The next points for consideration are the detection and removal of moisture and, incidentally, any minor impurities.



Effect of Moisture upon Insulation Resistance of Oil

The presence of moisture in transil oil may be detected in various ways, but in order to test for moisture, it is customary to draw a sample of oil from the suspected transformer tank or switch box and test the sample. This should be taken from the bottom of the tank because the water has a tendency to settle to the bottom. A sample can best be drawn by means of a "thief," which is a small piece of tubing; the thumb is held over one end of the tube and the other end is pushed down to the bottom of the tank; when the thumb is removed and the air pressure relieved, the oil fills the tube from the bottom of the tank and by replacing the thumb and drawing the tube from the tank a sample will be obtained which will represent the condition of the oil at the bottom.

Two methods have been found most suitable for testing oil for the presence of moisture; one is to heat a piece of wire or a nail red hot and drop it into the oil. If there is any moisture present, it can always be detected by a crackling and snapping sound which occurs when the red-hot wire is immersed. Dry oil will simply give a sizzling sound, which can readily be detected as of quite different nature. This method is the one most used, because of its convenience, but it does not show the presence of moisture as sensitively as the second method, which consists in placing some of the oil in a porcelain or glass dish and heating it very rapidly. A crackling sound similar to that produced by dropping in a red-hot wire will be noticeable if moisture is present. Neither method will detect very small percentages of moisture.

A number of schemes have been tried for "drying" transil oil to remove the moisture and several have been mentioned briefly at different times in the columns of Power. H. W. Tobey, in a recent number of the *Proceedings* of the American Institute of Electrical Engineers, has described these methods very thoroughly, but as it is probable that a majority of the readers of Power do not see the *Proceedings*, it may be well to give the gist of Mr. Tobey's paper. The chief methods of "drying" are (1) by the use of chemicals; (2) by the application of heat in some form; (3) by mechanical means and (4) by filters.

The first method is the one most used by central-station men, because they do not, as a rule, have the use of the elaborate paraphernalia usually required for the other treatments. The best known of the chemical methods is dehydration of the oil by means of metallic sodium. When metallic sodium is dropped in oil containing moisture it combines with the moisture very readily, forming caustic soda and liberating hydrogen gas; hydrogen is, of course, highly inflammable and care must be taken that no flame is in the vicinity when the "drying" is being done. This method is open to the objection that the caustic soda is very apt to attack the insulating varnishes and compounds used in the manufacture of the transformer and soften and weaken them considerably. Whether or not this will take place when the insulation is actually protected by the oil has not yet been determined, but it would not be considered good practice to run this risk.

The best and surest chemical drier is calcium chloride, which has a strong affinity for water and consequently has a strong dehydrating action. No objectionable chemical combination is formed when this is used, and the calcium chloride will not attack any of the material of the transformer. Dry, unslacked lime or calcium oxide can also be used for this purpose and so can calcium carbide, but both of these are comparatively slow in action, as compared with sodium and calcium chloride; the latter is the most rapid of any. These "drying" agents can best be used by putting them in a can plentifully perforated with small holes and hanging it in the oil. If they are applied in this way instead of being thrown in loose it is possible to remove them as soon as the oil is freed of its moisture and thus avoid the chance of having dirty oil. It usually requires nearly 75 hours for calcium chloride to restore transformer oil to its original dielectric strength and sodium requires as much as 120 to 150 hours, so it can readily be seen that these cannot be considered very rapid "driers."

It is often customary to dehydrate transil oil by means of heat, but this

*Page 1862, October 18, 1910.

process is very slow and not at all sure. Great care must be taken not to overheat the oil for fear of carbonizing it. This process can be varied by putting the oil in a closed tank in which a vacuum is maintained, as this will cause the moisture to dry out more rapidly, or the oil may be heated and dry air blown through it, the air being employed as an agent to carry the moisture away.

Moisture can be removed from transil oil to some extent by means of centrifugal machines, such as a cream separator, and a mixture of oil and water, which will contain the greater part of the water that was in the oil before treatment, can be removed from the circumference of the separator runner. This will not remove the moisture entirely and it is customary to filter the oil afterward to remove the remainder of the moisture. It is also possible to remove much of the water, if present in large proportion, by allowing the oil to stand undisturbed long enough for the water to settle to the bottom. This, however, will not bring the oil up to the standard which it should have.

The most modern means of dehydrating transil oil thoroughly is the filter press. It is well known that some substances will permit oils to pass through them, but will not pass water. Those who have strained gasolene through chamois skin to remove water will appreciate this. For this process a common type of large-capacity pressure filter is used such as may sometimes be found in large chemical laboratories. A quantity of perfectly dry blotting or filtering paper is placed between the plates and the oil forced through at a pressure in the neighborhood of 50 pounds per square inch. The filtering paper not only has the effect of removing all moisture, and probably absorbs the moisture which it does remove, but it also has the advantage of removing all dirt which may be mixed with the oil. Oil treated by this process will always come through in excellent condition, and if it does not test out as well as can be wished for, it is a very easy matter to run it through a second time. The filtering paper must be replaced from time to time as it becomes clogged with dirt, but it is only necessary to replace the top sheet in each pack of paper, as the first one always catches all the dirt. This is probably not only the best but the cheapest and easiest way to clean oil, as it is only necessary to start the apparatus and it will keep going until the tank is empty.

Some care must be taken that the oil does not come in contact with other substances besides moisture which may affect it. Chief among these is sulphur, which is to some extent soluble in oil and has often in the past been used in transformers as a cement. This is now considered particularly bad practice and the best transformer builders have long since abandoned any use of this material in their apparatus; moreover, they are usually careful to see that little sulphur is contained in the rubber-covered leads which are often used in transformer cables on the terminals within the case. It formerly was thought that sulphur would reduce the dielectric strength of the oil, but tests that I have made have failed to show this to be a fact, and the dielectric strength has never at any time shown impairment, even with a large percentage of sulphur.

The really serious objection to the presence of sulphur is that it attacks and corrodes copper very readily, and where there were fine-wire windings in the apparatus it has been known even to eat the copper away until an open circuit was formed. The presence of sulphur is easily tested for on account of the fact that it will blacken copper so readily; if a small portion of the suspected oil be heated and a bright copper wire hung in it, the copper will usually show the blackening effect of the sulphur within a few hours, if any sulphur be present.

Oil which has been overheated for a great length of time and to a very considerable extent grows black and dirty due to the carbonizing effect. It will also attack to a limited extent the insulating and waterproofing compounds with which most transformer windings and other coils are impregnated. The formation of the carbon in the oil will tend to reduce the insulating quality, but it is doubtful whether the solution of the impregnating gums from the coils will seriously injure the oil, although it does give it a dirty appearance. Running such an oil through a filter press, as mentioned before, will remove both of these impurities, so that an oil thus treated will usually be restored to its original appearance.

With reasonable care the life of transil oil can be prolonged beyond that which is usually attained, and as this is not at all an inexpensive supply it is well worth the trouble of a little study of its care and treatment.

Single Phase Traction in France

One of the latest examples of the substitution of electric for steam locomotives in France is the Midi railway. The portion to be "electrified" is some 70 miles long; the country is very hilly and there are several bad grades, one of 3½ per cent. being about seven miles long. It is stated that the electrical equipment will eventually be extended to the entire Toulouse-Bayonne Line, a distance of 200 miles.

The Midi Railway Company has ordered equipments for 30 double-truck motor coaches for passenger service and an electric locomotive for freight service. Each of the passenger coaches will seat about 50 passengers and will be equipped with four 125-horsepower Westinghouse single-phase motors built for 16⅔ cycles and 285 volts. These motor coaches will be able to haul trailers weighing 44 metric tons (97,000 pounds), besides its own weight and load, at a speed of 45 miles per hour on level track.

The Midi locomotive will be provided with five axles, three of which will be driven by two 600-horsepower motors through jack shafts and connecting rods. The locomotive will weigh 80 metric tons (176,000 pounds) and will be able to haul trains weighing 320 metric tons, exclusive of the locomotive weight. With a haulage load of 280 metric tons the speed will be 25 miles per hour, and with 100 metric tons about 38 miles per hour.

The current will be supplied to the locomotive and motor cars by means of a 12,000-volt overhead catenary line and stepped down to motor voltage by transformers on the cars. The pantograph type of trolley will be used.

LETTERS

Too Much Bolt and Washer

During the latter part of July, our company bought three second-hand electric coal-cutting machines, with chain cutters, and we started in to overhaul them and put them in good running order. Two of the machines tested clear with the magneto but the third showed a ground, the bell ringing at whatever point the magneto terminal touched. After disconnecting the field terminals and removing the commutator brushes, we tested these and found them all clear, showing that the trouble was with the rheostat. When testing the rheostat the magneto rang as soon as the terminal touched any of the various contacts or even the machine frame, and the fact of getting a ring when touching the frame led us to look for trouble at the points where the rheostat is screwed to the machine frame. At each of these points a cap screw passes through the front plate and through a short distance piece of pipe, and then enters the screw hole in the machine frame. A washer is inserted between the pipe and the rheostat plate, and this washer was so much larger than necessary that it touched the bottom of the resistance conductor, giving a path for the current to pass to the machine frame. By putting on smaller washers this trouble was cleared, but the main trouble remained, that is, the rheostat tested up at every point grounded on its frame. We finally discovered that in mounting the cable binding post on the face of the rheostat, the post had been placed directly opposite one of the screws which holds the bottom resistance frame to the faceplate and the two screws from opposite sides of the faceplate came together, mak-

ing the short-circuit direct from the live cable binding post, through the screws to the resistance conductor, and thence through the washer and cap screw to the machine frame.

RICHARD CLEMENS.

Canal Dover, O.

Polarity Indicators

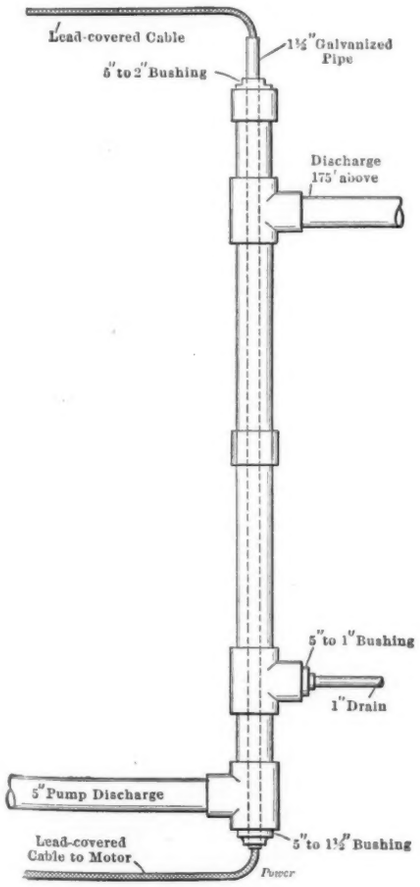
The simple method of determining the polarity of two direct-current conductors described by Wesley McArdell in the September 27 issue is all right except that it is not always convenient to get a potato in a power plant. Were Mr. McArdell to spit on a board and insert his two wires in it about ½ or ⅝ inch apart he would find around one of the wires the same green discoloration due to the copper dissolved from the positive wire.

WILLIAM T. GARLITZ.

McKees Rocks, Penn.

A Novel Wiring Conduit

Some time ago we installed an electric pump about 2000 feet underground. The drill hole for the discharge pipe had been put down and a 5-inch discharge pipe set in it. At that time we could not wait for another drill hole to be sunk through which to put the lead-covered cable to connect up the motor, and the nearest hole was that containing the exhaust pipe from the steam pump which the electric was to displace; this was approximately 700 feet away. We did not like to put the steam pump out of commission because something might go wrong with the electric pump, and the water must be kept out. After a good deal of thought as to the best way out of the dilemma, I used the scheme illustrated in sketch, and this has not given a moment's trouble since installed. It consists merely of running the motor cable through a 1½-inch pipe and putting that in the 5-inch discharge pipe of the pump.



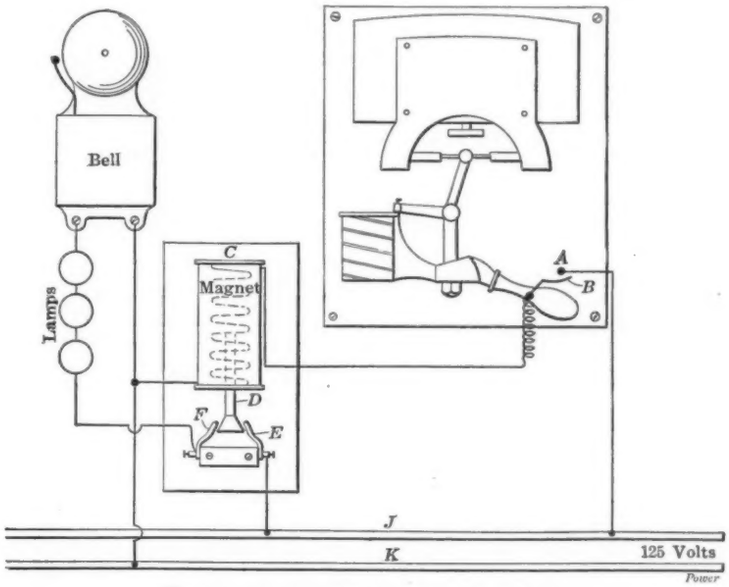
A NOVEL WIRING CONDUIT

L. EARLE BROWN.

Roundup, Mont.

Another Circuit Breaker Alarm

Mr. Warren's description last week of a simple mechanical arrangement for closing a bell circuit when a circuit-breaker goes out brings to mind an electrical system for accomplishing the same result which I saw some time ago in a Southern power house. This system is illustrated elementally by the accompanying diagram. To the circuit-breaker handle is attached a piece of spring wire *B* which is brought into contact with the pin *A* when the circuit-breaker opens. This pin is connected to the busbar *J* and the spring wire *B* is connected to one terminal of the magnet coil *C*, the other terminal of which is connected to the busbar *K*.



RELAY-OPERATED CIRCUIT-BREAKER ALARM

Consequently, when the circuit-breaker opens, the magnet *C* is energized by current from the 125-volt busbars *J* and *K*, and draws the plunger *D* up until the conical end bridges the spring contacts *E* and *F*, thereby closing a circuit from the busbars through the alarm bell and three incandescent lamps. The lamps serve as resistance to prevent too much current from passing through the bell magnet and also offset largely the inductance of the bell magnet, thereby preventing excessive flashing at the vibrator contacts and at the pin *A* and spring *B* when they are separated by closing the circuit-breaker.

This arrangement has the advantages that the alarm bell may be located at any desired place in the plant and that one alarm system will serve for any number of circuit-breakers. When any circuit-breaker is left open for a considerable length of time, a piece of rubber tubing is slipped over the pin *A* to prevent the bell from ringing uselessly.

GEO. W. MALCOLM.

Brooklyn, N. Y.

Humming Armature Cores

I noticed in an article recently published in POWER a discussion of humming in armatures and rotors. I have assembled several thousand cores of both kinds and only had one to hum. The cause was an improper fit between the disks and the housing of a stationary core, which caused a wavy appearance of the finished assembly. No machine assembled under a reasonable pressure per square inch of disk surface, where the variation of size is not over 0.0005 inch, will hum when running. The trouble with too tight a fit is that the disks will buckle and be tight at one point and loose diametrically opposite. A slight buckle will not hurt, if all the vent ribs have a bearing on the flanges.

ALFRED N. HAMMOND.

Erie, Penn.

The Inland Waterways Commission in America has reported that 150,000,000 water horsepower are running to waste, and if we remember aright this referred to North America alone.

Gas Power Department

Developments at the Deutz Gas Engine Works

By F. R. Low

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

At the conclusion of the recent European meeting of the American Society of Mechanical Engineers, some of the delegates visited a few of the prominent manufacturing establishments on the Continent, among them the Deutz Works at Cologne, which were established in 1864 by Doctor Otto and his partner, Eugene Langen, for the manufacture of gas engines. Large oil paintings and busts of the founders adorn the room in which we were received by the chief engineer, F. Hundeshagen, who kindly conducted us through the shops and told of the work being done there.

One of the interesting things that were seen was the first of the large double-acting gas engines; a 250-horsepower unit made in 1902. Readers of POWER of ten years ago will remember that the question of making the gas engine double acting was actively discussed at the time of the Paris Exposition. The difficulty lay in providing a stuffing box that would stand the temperature, and in water cooling the piston and rod. The engine just mentioned is said to be the first one of considerable size in which this was satisfactorily done, and it is still running successfully.

It is interesting to record that this company, which was so active in developing the double-acting engine, has been among the first to recognize its limitations and now builds everything single acting up to capacities which require the piston to be water cooled. The simple trunk piston, nothing but a hollow cylinder of cast iron with a few snap rings and a wristpin for the connecting rod, is so concrete and satisfactory an arrangement to use with the high temperatures and great forces involved in gas-engine work that the Deutz people have come back to it wherever it is practicable and have concluded that it is better to make the engine a little larger and to run it a little faster, or even to use more cylinders for a given engine, than it is to complicate the engine with stuffing boxes and water-cooled rods and to add to its length, cost and number of parts by putting in crossheads and guides. They can get 200 horsepower out of a single cylinder without water cooling the piston, and by using four such cylinders can supply a compact simple engine of 800 horsepower, free from liability to lubrication troubles and leaky cooling systems, and at a lower cost than that of the more complicated and delicate double-acting machine.

The company has a design in which two cylinders are cast together, side by side horizontally, and deliver power to cranks set at 180 degrees, avoiding the necessity of counterbalances for the crank webs and giving a fairly uniform turning moment. The shaft extends at one side and is supported by an outboard bearing. They have had no difficulty with cylinder breakage and do not hesitate to cast working barrels up to 75 millimeters(practically 3 inches) thick. They avoid tying together parts that are subjected to different temperatures and avoid breakage in rods by a liberal use of nickel steel. Their valves are of cast iron with nickel-steel stems. They get 1000 horsepower from a single cylinder of 1000 to 1100 millimeters (39 to 43 inches) bore and 1300 millimeters (50 inches) stroke, with 90 to 92 revolutions per minute, and have built several tandem two-cylinder and twin-tandem four-cylinder engines of 2000 horsepower.

The Deutz company builds producers for all sorts of fuel and service. Peat, Herr Hundeshagen said, works well in a producer when it contains not more than 25 per cent. of moisture.

The company also makes many engines to run upon benzol, a coke-oven byproduct. From 230 to 250 grams (8.1 to 8.8 ounces) per brake horsepower-hour are required and it costs from 16 to 17 marks per 100 kilos (1.8 to 1.9 cents per pound). Its heat value is from 9300 to 9500 calories per kilo (about 16,750 to 17,000 B.t.u. per pound). Little, compact six-cylinder engines, three cylinders on each side, inclined away from the vertical, are made for use with this fuel on railway cars for local service. The engine drives a generator which supplies current to motors upon the axles. There is automatic regulation of the generator output to give the large amperage and low voltage required for starting and the higher voltage and lesser current required for running at speed, and as the engine runs at constant speed, the full power is available for starting up. The company builds also a kerosene engine called the Brons, self-igniting without flame or spark, but with high compression like the Diesel. It is built up to 32 horsepower and is much used for fishing and freight boats. Large engines of the Diesel type, working on the four-stroke cycle for stationary service and the two-stroke cycle for marine service, are also built. Little narrow-gage locomotives of 12 to 50 horsepower are another attractive product, of which about 900 have been built.

The Deutz foundry work is admirable—so fine, in fact, that the company has abandoned bronze and cut spiral gears for running lay shafts in favor of cast gears run as they come from the mold, without any machine work upon their working faces. They are split so as to be easily placed upon the shaft, the split extending along the diagonal bottoms of opposite teeth, and run in oil.

Efficient Gas Cleansing

As an example of modern methods of purifying producer gas, the equipment of the Penn-American Plate Glass Company, at Alexandria, Ind., is of interest. A portion of the company's power equipment consists of a producer-gas engine plant comprising three 500-horsepower Körting engines and a 300-horsepower Westinghouse engine, all direct connected to electric generators. These engines are supplied with gas by four 500-horsepower up-draft soft-coal producers of the pressure type. No gas holder is used but the producers are supplied with forced draft by means of steam jets which provide sufficient pressure to overcome resistance of the fuel bed and to deliver the gas into the main under a pressure of from 1½ to 2½ inches of water; from the main the gas passes through a cooling tower to a two-stage centrifugal scrubber and tar extractor of the turbine type, built by the Buffalo Forge Company.

The four gas engines run continuously 24 hours a day and 6 days a week, and it is reported that examination at the end of each week has shown cleaning of the engines to be unnecessary. We are also informed that after several months of regular service not the slightest trace of tar or lampblack was to be found in the gas main leading from the scrubber, and that the freedom from tar and lampblack is so complete that the governors regulate perfectly, no trouble having been experienced from this source since the installation of the Buffalo scrubber.

Accident Due to Careless Governor Construction

By Earl Pagett

A peculiar accident occurred recently to the governor on one of the gas engines under my charge, both of the governor arms being broken off about as indicated at *I* in Fig. 1. The governor was of the centrifugal flyball type, geared to the main shaft through one set of spur gears and a set of miter gears.

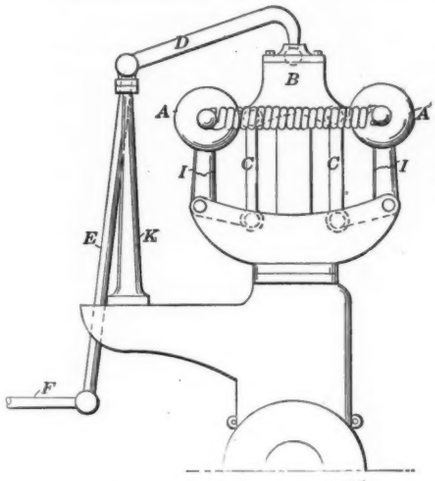


Fig. 1. The Governor

The sketch, Fig. 1, will serve to give an idea of its general construction. It is evident that centrifugal force tends to throw the weights *A* and *A'* apart, thereby raising the cap *B* through the links *C*, and giving motion to the levers *D* and *E* and the reach rod *F* which operates the gas valve. Two stout helical springs oppose the centrifugal effect on the balls.

Fig. 2.

Fig. 3.

The ends of the springs are bent around the pins in the balls as at *H*, Fig. 2, these eyes fitting into grooves *J*, Fig. 3.

This engine and another of about the same size are belted to the same line shaft, each one having its own clutch. Ignition current is normally supplied by magnetos driven from the line shaft, but batteries are used in starting up. The man who operates the clutches is instructed to throw the igniter circuit switches over so that the igniters will take current from the batteries as soon as he throws out the clutches for any reason, in order not to shut down the engines by the shutting down of the magnetos.

About noon, while I was in one of the other engine rooms, the clutches were thrown out, and the magnetos stopped. The foreman did not throw the switches over to the batteries until the engines had slowed down considerably; then he changed the switches over to the batteries and things began to happen that sounded like a ragged volley of rifle shots.

I had just blown the whistle for noon and was on my way to stop these two engines when I heard the noise. When I reached the room the governor weights and springs were lying around promiscuously, but the foreman had had enough presence of mind to pull the igniter switches and shut down the engines.

The only theory that I can suggest to explain the accident is that one of the springs jumped off its pins, allowing the weights to be thrown out far enough to strike the pedestal *K*.

Of course, they would have caused the governor to shut the gas entirely off before striking if the engine had been running alone, but as it was connected to the line shaft with the other engine, the speed was kept up enough to cause the balls to strike; after they broke off, the centrifugal force was not great enough to hold the stub ends out and the engine ran away when the switch was thrown over to the battery.

To prevent any chance of the springs getting off again, I drilled holes and put in cotter pins, as at *L*, Fig. 3.

Lloyd's Rules for Marine Engines

Lloyd's Register of British and Foreign Shipping recently issued the following rules for the survey of internal-combustion engines for marine purposes:

Section 1. General

In vessels propelled by internal-combustion engines the rules as regards machinery will be the same as those relating to steam engines so far as regards the testing of material used in their construction and the fitting of sea connections, discharge pipes, shafting, stern tubes and propellers.

Section 2. Construction

The following points should be observed in connection with the design of the engines:

2. The shaft bearings, connecting-rod brasses, the valve gear, the inlet and exhaust valves must be easily accessible.

3. The reversing gear and clutch must be strongly constructed, and easily accessible for examination and adjustment.

4. In engines of above 60 brake horsepower which are not reversible, and which are manœuvered by a clutch, a governor or other arrangement must be fitted to prevent racing of the engine when declutched.

5. Efficient positive means of lubrication—preferably sight feed—must be fitted to each part requiring continuous lubrication.

6. If the engines are of the closed-in type they must be so arranged that the lubricating oil can be drained when necessary, and in wood vessels an easily drained metal or metal-lined tray must be fitted to prevent leakage of either fuel oil or of lubricating oil from saturating the woodwork.

7. Carbureters and vaporizers should be so designed that when the engine is stopped the fuel supply is automatically shut off. If an overflow is provided in the carbureter or vaporizer, a gauze-covered tray with means of draining it must be fitted to prevent the fuel from flowing into the bilges.

Strong metallic-gauze diaphragms should be fitted either between the carbureter (or vaporizer) and cylinders or at the air inlets.

8. If the ignition is electric, either by magneto or by coil and battery, all electric leads must be well insulated and suitably protected from mechanical injury. The leads should be kept remote from fuel pipes, and should not be placed where they may be brought into contact with oil.

The commutator must be inclosed, and the spark coils must not be placed where they can be exposed to explosive vapors.

9. No exposed spark gap should be used.

10. In kerosene and heavy-oil engines, where lamps are used for ignition or for vaporizing, these lamps should be supported by some suitable bracket and the flame inclosed when in use.

11. The circulating-pump sea suction is to have a cock or valve on the vessel's skin placed on the turn of the bilge in an easily accessible position, and the circulating pipe is to be provided with an efficient strainer inside the vessel. The discharge overboard is to be fitted with a cock or valve on the vessel's skin if it is situated under or near the load line of the vessel.

12. A bilge pump worked by the engines, or an independent power-driven bilge pump, is to be arranged to draw from each part of the vessel. In open launches this bilge pump may be omitted, provided suitable hand pumps are provided.

13. The cylinders are to be tested by hydraulic pressure to twice the working pressure to which they will be subjected, the water jackets of the cylinders to 50 pounds per square inch and the exhaust pipes and silencer to 100 pounds per square inch.

14. The exhaust pipes and silencer should be efficiently water cooled or lagged to prevent damage by heat, and if the exhaust is led overboard near the water line, means must be arranged to prevent water from being siphoned back to the engine.

15. The machinery must be tried under full working conditions, the report stating the approximate speed of vessel,

the number of revolutions of the engines at full power, both ahead and astern, and the lowest number of revolutions of the engines which can be maintained for manœuvering purposes.

SECTION 3. RULES FOR DETERMINING SIZES OF SHAFTS

The crank, intermediate and other shafts, if of ordinarily mild steel, are to be of not less diameters than as given in the following table. When special steel is used the sizes are to be submitted for consideration.

1. For gasolene or kerosene engines for smooth-water service:

Diameter of crank shaft, in inches, =

$$C\sqrt[3]{D^2S}$$

where

D = Diameter of cylinder in inches;
S = Stroke of piston in inches.

Four-stroke Cycle.	Two-stroke Cycle.	Bearing between Each Crank.	Two Cranks between the Bearings.
For 1, 2, 3 or 4 cylinders..	1 or 2 cyls.	$C = 0.34$	$C = 0.38$
6 cylinders..	3 cyls.	$C = 0.36$	$C = 0.40$
8 cylinders..	4 cyls.	$C = 0.38$	$C = 0.425$
12 cylinders..	6 cyls.	$C = 0.40$	$C = 0.49$

For open-sea service add 0.02 to C.

Diameter of intermediate and screw shafts, in inches, $= C\sqrt[3]{D^2S(n+3)}$

where

D = Diameter of cylinder in inches;
S = Stroke of piston in inches;
n = Number of cylinders.

For smooth-water service,

$C = 0.155$ for intermediate shafts;
$C = 0.170$ for screw shafts fitted with continuous liners;
$C = 0.180$ for screw shafts fitted with separate liners or with no liners.

For open-sea service,

$C = 0.165$;
$C = 0.180$;
$C = 0.190$.

In engines working on the two-stroke cycle n is to be taken as twice the number of cylinders.

2. When ordinary deep-thrust collars are used, the diameter of the shaft between the collars is to be at least 21/20ths of that of the intermediate shaft.

3. In the cases of Diesel and other engines in which very high initial pressures are employed, particulars should be submitted for special consideration.

SECTION 4. FUEL TANKS AND CONNECTIONS

1. Separate fuel tanks are to be tested with all fittings to a head of at least 15 feet of water. If pressure-feed tanks are employed, they are to be tested to twice the working pressure which will come on them, but at least to a head of 15 feet of water. If the tanks are made of iron or steel they should be galvanized.

2. Strong and readily removable metallic-gauze diaphragms should be fitted at all openings on gasolene tanks.

3. Kerosene or heavy-oil tanks, not used under pressure, are to be fitted with air pipes leading above deck. Pressure-feed tanks and tanks containing gasolene should be provided with safety valves discharging into pipes leading to the atmosphere above deck. The upper ends of all pipes are to be turned down, and pipes above 1 inch in diameter are to be provided with gauze diaphragms at the end.

4. No glass gages are to be fitted to fuel tanks containing either gasolene, kerosene or heavy oil.

5. Filling pipes are to be carried through the deck so that the gas displaced from the tanks has free escape to the atmosphere.

6. Separate fuel tanks should be provided with metal-lined trays to prevent any possible leakage from them flowing into the bilges or saturating woodwork. Arrangements are to be provided for emptying the tanks and draining the trays beneath them. For gasolene tanks the trays must have drains leading overboard where possible, or they should be gauze-covered trays with means for draining them.

7. All fuel pipes are to be of annealed seamless copper, with flexible bends. Their joints are to be conical, metal to metal. A cock or valve is to be fitted at each end of the pipe conveying the fuel from the tank to the carbureter or vaporizer. The fuel pipes should be installed in position where they are protected from mechanical injury and can be exposed to view throughout their whole length.

8. The engine room and the compartment in which the fuel tanks are situated are to be efficiently ventilated.

9. An approved fire-extinguishing apparatus must be supplied.

SECTION 5. PERIODICAL SURVEYS

1. The machinery is to be submitted to survey annually. At these surveys the cylinders, pistons, connecting rods, crank and other shafts, inlet and exhaust valves and gear, clutches, reversing gear, propeller, sea connections and pumps are to be examined. The electric ignition is to be examined and the electric leads tested. The fuel tanks and all connections are to be examined, and, if deemed necessary by the surveyor, to be tested to the same pressure as required when new. If practicable, the engines should be tested under working conditions.

2. The screw shaft is to be taken out at intervals of not more than two years.

Setting Small Engines

In the issue of September 20, George W. Malcolm, in criticizing my method of setting small gas engines, evidently overlooked the word "small" in the title of my article. However, I do not know what the limit of size is for engines that can be set in the way I described, but I have set them weighing 2½ tons without doing any "acrobatic stunts." The only acrobatic stunts that I have found necessary are those of the mental order, and I find that those are necessary on about all classes of work.

No fixed rule for placing the jacks can be given, as engines and conditions vary. In setting a horizontal engine, I use three jacks, one under the head and one under each end of the crank shaft. The engine can very easily be braced sidewise to maintain the proper alinement during the operation.

H. K. WILSON.

New Bedford, Mass.

A Lucky Escape

A rather unusual accident happened recently in a large plant of Diesel engines where I am employed. During the work of changing over the exhaust piping so it would pass out at the roof a ¾-inch bolt 4 inches long was left, unknowingly, in one of the admission-valve cages. On starting up the next morning the engine ran all right for a few minutes; then the bolt worked by the admission valve and dropped into the cylinder, causing a heavy jar. The engine was at once shut down and the trouble located by barring the flywheel around until the affected cylinder was identified. The head was taken off and the stray bolt discovered and removed.

We found the admission and exhaust valves badly sprung, but that was the only damage that was done. The valves were straightened and reseated and by night the engine was ready for its load again. We thought ourselves lucky to get off so lightly; the cylinder head might easily have been cracked under such a strain.

RICHARD L. SUTER.

Southbridge, Mass.

The total water power of the State of New York, without including that of the Niagara and St. Lawrence rivers, has been estimated at a million and a half. Eight hundred and eighty thousand of this is undeveloped. The New York Water Supply Commission has recently recommended that the State expend $20,000,000 to develop this water power, which it estimates would return an annual profit of $1,400,000.

In 1902 Russia produced 2,000,000 tons of peat fuel. This quantity is more than any other nation produced in that year.

Readers with Something to Say

Thermometers versus Gages

The engineering profession appears to be definitely committed to measuring steam pressure in pounds per square inch above the atmosphere, and, to add confusion, pressure below the atmosphere is stated as a vacuum in inches of mercury. This is an age of reform, and a simple and logical change, that has already found favor with experts, is to substitute temperature as measured by the thermometer.

When the theoretical side is considered it can be shown convincingly that the engineer must learn to think in terms of temperature if he wishes to get the right perspective, but it is not so easy to convince the practical engineer that he ought to substitute a little glass thermometer for his big nickeled gage. Unless the thermometer makers will provide instruments that can be read easily across the engine room the gage will have a decided advantage. Fortunately, the gage usually tends to read high, which is on the side of safety, though it may lead to disappointment in performance. The engineer frequently shows a naïve confidence in an imposing array of gages, but he would do well to occasionally pull out the pin at the zero mark and note how much too slow his gage registers.

There appears to be no reason why the thermometer in the boiler room should not be placed by the side of the gage glass, nor any reason why it could not be made to show up as positively as the latter. In the engine room there might be some difficulty in maintaining a circulation of steam through the thermometer cups if they are to be set side by side on a "thermometer board" but greater difficulties than this have been solved.

The great advantage of the thermometer would be that when once correctly graduated it would remain accurate until broken, which disaster would be improbable with the proper care. Physicists may bother about the zero point changing a fraction of a degree, but this would not concern the engineer.

A simple problem solved by the aid of the steam and entropy tables will show the theoretical advantages of this contention. Let the steam be expanded adiabatically from 420 to 100 degrees Fahrenheit; that is, from 293 pounds gage to 28 inches vacuum. To bring out the point in question let the expansion take place in ten equal steps. The heat contents in the entropy column 1.52 and their difference are as follows:

At 420 degrees	1212.5 B.t.u.
At 100 degrees	845.9 B.t.u.
Difference 320 degrees	366.6 B.t.u.

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Divide this heat drop into ten parts of 36.66 B.t.u. each and subtract these successively in the following table:

Heat Contents.	Temperature.	Pressure. Absolute.	Pressure. Gage or Vacuum.
1212.5	420	308	293
36.66	3	108	
1175.84	382	200	185
36.66	37	74	
1139.18	345	126	111
36.66	35	48	
1102.52	310	78	65
36.66	34	32	
1065.86	276	46	31
36.66	32	19	
1029.20	244	27	12
36.66	31	12	
992.54	213	15	0
36.66	30	7	
955.88	183	8	14
36.66	28	4	
919.22	155	4	22
36.66	28	2	
882.56	127	2	26
36.66	27	1	
845.90	100	1	28

The first column gives the heat contents for the intermediate points, the small figures being the differences. Looking in Peabody's "Steam and Entropy Tables" under the entropy column 1.52 the nearest corresponding temperatures and pressures are found, neglecting fractions of a degree or pound. These quantities are inserted in the preceding table under the headings "temperatures and pressures absolute." Thus the first drop of 36.66 B.t.u. causes a fall in temperature of 38 degrees, while the pressure drops from 308 to 200 pounds. The temperature differences diminish as 38, 37, 35, etc., to 27; but the pressure differences run, 108, 74, 48, etc., to 1. The last column, with the break from gage pressure to inches of vacuum, is given to emphasize the inconvenience of the customary method.

How can engineers keep in mind that a drop of 2 inches of mercury, from 26 to 28, represents the same number of heat units given up as in a drop in pressure of 108 pounds, from 293 to 185 pounds gage. While it is true that 27 degrees are not the same as 38 degrees, it is the same kind of a magnitude.

For the sake of simplicity the drop was taken as adiabatic; had it been taken as varying from the adiabatic, the computation would have been somewhat more intricate, but the advantage of counting in degrees instead of in pounds would have been equally evident. This is one of the advantages that has come from the attention that steam-turbine engineers have given to theoretical considerations.

C. H. Peabody.

Boston, Mass.

Why Are There Not More Writers among Engineers?

It is surprising that so few engineers take an interest in contributing to the "practical information" columns of engineering journals. I can see no method that could be a greater help to young engineers than following the teachings obtained through the experience of others. It behooves engineers to give out all the information they can to help the younger and less experienced men, as well as for the betterment of the trade in general. At times it seems that there exists a feeling of jealousy among the engineers, for there are many well informed men in the country who could contribute a few lines now and then which would be of much help, but from these people little of the much desired information is to be had.

To illustrate how a few lines along most any line might help someone, I will relate a personal experience of some years ago. I had seen much of steam-pipe covering in place, also covering on heaters, separators, etc., but it was some time before I obtained exact facts as to applying the covering to traps, heaters, small boilers, etc. I was working as oiler with an experienced engineer and under a first-class chief, but found that they lacked the best knowledge along this line as they attempted to cover a trap and separator by applying a paste so fast that it came off before having a chance to dry and they were forced to give up the attempt. I concluded it must be quite a trick and set out to obtain the required information. After looking over many engineering papers and books, I secured very little information on the subject, but by watching out and picking up points here and there, along with experiments of my own, after about two years I had satisfied myself that I could do the work. For the benefit of those that have not acquired that knowledge I will give a description of my method of applying covering to small boilers, heaters, etc.

To start with, it is best to have the surfaces warm (not hot) and free from dust or grease. Apply the covering in coats; the first coat, being the most difficult, is put on by having the covering mixed with good paste and applied by pressing it against the surface in small balls until the entire surface is covered, with the edges of each ball just touching. After this has dried, go over it and plaster, by hand or trowel, between the balls until the whole surface is covered, and continue in this manner until the required thickness is reached, which should not be less than ½ inch. Now, bind it tightly with a fine iron wire or a small-mesh chicken-wire netting and apply another coat of asbestos about ½ inch thick. After this has dried repeat the operation until the required thickness is obtained. The last coat, which is about ½ inch thick, consists of a mixture of one-half asbestos and one-half portland cement. This should be applied with a trowel, a smooth finish being attained by dipping the trowel in water. This gives a hard finish which is much easier to keep clean and resists moisture from the dripping water and condensed steam better than a covering of canvas. The great trouble in applying covering of this kind is that the inexperienced man is apt to put on too much paste in the beginning and not allow it to dry before applying the second coat. By taking time and having patience most anyone can make a good job of covering any kind of a vessel.

Gas and gasolene engines seem to be a sort of bugbear to a great many steam engineers, but I believe that if they would read a good engineering journal regularly and concentrate their minds on it as much as they do on the baseball news, it would not be long before they would be walking around with a chip on their shoulders looking for someone to say something against the internal-combustion engine.

When a good engineer finds that his boiler needs washing he hustles into his jumper and overalls and cleans it. Just so with the engineer that keeps abreast of the times; when he sees a new thing that looks good, he gets busy with the books and magazines and learns all about it. These engineers are the ones that are holding the good jobs, from whom we hear no complaint and from whom the less important members of the trade receive but little information as compared with what they should.

One of the subjects that I would like to see discussed more in the columns of engineering journals is that of handling men and running the business end of plants. I believe there are any number of men whose experience along these lines would be of interest and value to many readers of POWER.

B. P. GAGE.

Keshena, Wis.

The Engineer Proved That He Was onto His Job

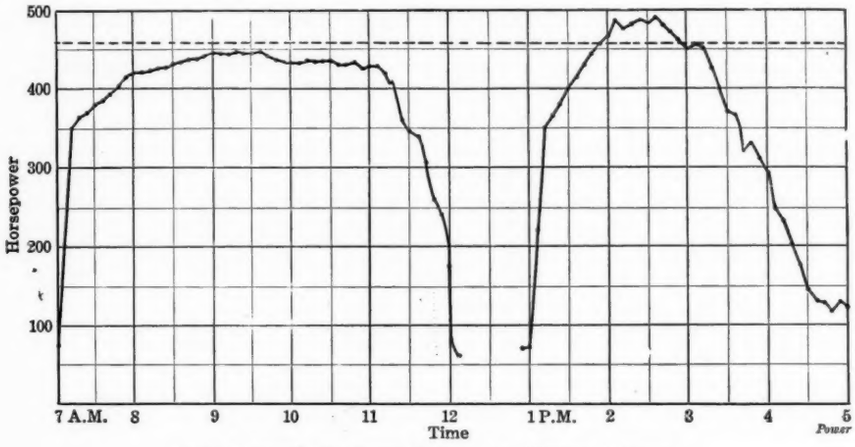
In a certain manufacturing plant in New England, it was told around that out in Illinois, where another branch of the firm was situated, they were producing the same article much cheaper than we could. Of course, the old man began to wonder as to the cause. First he attributed it to too much clerical, office and drafting-room expense, but after going into the matter carefully he decided that it would not help matters much even if a couple of men were dispensed with.

The shop had good machines, employed good help, had the latest ideas on piecework, the boilers were burning all the sawdust to help out the fuel bill, the engine was in good condition, and from the superintendent to the least important foreman, nobody knew why it cost more in the Eastern than in the Western plant.

It was finally decided that because the Western plant ran the machines on each floor by an independent motor, whereas the home plant took all the power direct from the engine by means of belts and shafting, that much power was lost through friction in driving the shafting. The only way to compete with the other plant then was to install the same system of motive power or a new electric system and do away with all the big shafting, heavy belts, etc.

The engineer was consulted and asked to take an indicator diagram about five minutes to seven in the morning, another ten minutes past seven and another at noon. Each man was to leave his machine running for a few minutes in order to find out the power required to run the shafting, the peak load and the load of the shafting and machinery combined. The engineer did as he was told, finding that it required 75 horsepower to run the shafting, and that the peak load did not come at a quarter past seven but near 10 a.m. and 2 p.m. This fact, however, he kept to himself, reporting only a peak load of 475 horsepower, and a load of 150 horsepower for the shafting and machinery after the whistle had blown. After sending these figures to the office he began to think that perhaps the indicator was wrong or that some mistake had been made in using the planimeter, for why did the load drop off at four o'clock?

The next day, after looking over every joint on the indicator, and commencing at ten minutes to seven in the morning, he took a diagram every ten minutes all morning until ten minutes past twelve, then again at ten minutes to one until ten minutes past five at night. He put these in his pocket when he went home to supper and that night figured them all out. After getting them into shape he plotted the curves shown in the accompanying diagram; these showed that the fellows let up on their work by three o'clock and visited until the whistle blew. These were the cold facts and it was up to him to disclose them.



LOAD CURVE SHOWING PEAKS AT WRONG HOURS

The next morning after the superintendent had been in the office a few minutes, the engineer walked in and showed the results of the day before, pointing out where the actual loss was. After the engineer left, there were some lively doings in the office where the schedules were made up. They figured out the area, as shown by the dotted lines, then the actual amount covered by the curves and decided that a 15 to 25 per cent. cut in the wage rates would help matters. The notice went around and on Monday morning the new scale went into effect. Strange to say, it was actually welcomed, except by some of the old fossils who sighed a little. Some of the private boxes under the benches had to yield up their contents for a few days, but the men very soon had everything going on as before the cut. This proved to be where the extra expenses was located. As for the engineer, I do not know whether he received a raise or not, but I do know that if he had asked for one he would have received it.

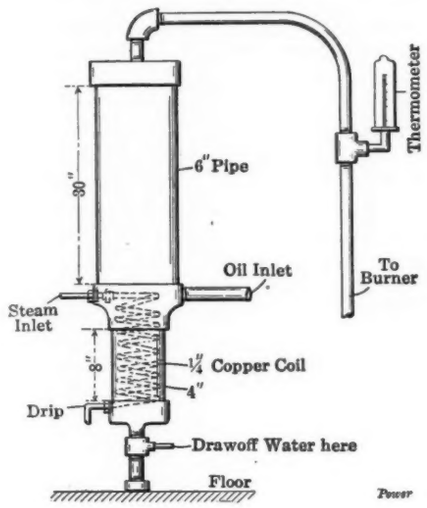
G. C. ABBE.

Brooklyn, N. Y.

Separating Water from Oil

I have found that in using oil fuel, enough water sometimes gets into the oil to cause much annoyance. The oil is shipped to this city by boat, and at times three to five barrels of water are present in a tank containing twenty-five barrels of oil.

As a usual thing the suction pipe reaches to within 2 to 4 inches of the bottom of the storage tank, and after a few barrels of water get into the storage tank, it is not unusual for the oil pump to draw nothing but water during several strokes. This becomes a nuisance when one is using a small fire in a large furnace, as a very little water will put out the fire. The furnace being hot and no flame being present when the oil is again ejected from the burner, a gas is immediately generated which is decidedly unpleasant as well as dangerous.



SEPARATOR

After having had a siege of this sort for several days, I thought out and constructed the separator shown in the accompanying sketch, which requires very little room and not much ingenuity to make. The separator is made of 6- and 4-inch pipe with ¼-inch copper pipe for the heating coil. Inside the 4x6-inch reducer a ¼-inch ground union is placed and the lower end of the coil is tapped into a 1¼x4-inch reducing coupling.

When there is any evidence of water in the oil, steam is turned into the inlet and the drip pipe is throttled just enough to allow the condensation to escape. The oil inlet is on a level with the steam inlet and when the oil becomes hot the water separates very readily and can be drawn off through the drain provided for that purpose. I have used this apparatus for over two years and have found it very satisfactory.

H. R. ROGERS.

Seattle, Wash.

Device for Taking Up Slack in Indicator Cord

Nearly all of the steam-engine indicators upon the market are equipped with a detent motion, but in the majority of cases this means simply a pawl which can be thrown in to engage with teeth cut on the bottom of the indicator drum and no provision is made for taking up the slack cord between the indicator drum and the bushing of the reducing wheel. This slack cord is very apt to catch on some part of the instrument and either break or cause damage, much to the annoyance of the engineer. There are several devices upon the market for taking up the slack in the cord but after trying several I found them unsatisfactory on account of their short life, due to the use of springs which soon weakened or broke when used on high-speed engines, or otherwise they were clumsy and in the way of the operator. I therefore submit the following description of a device for taking up the slack in the cord which has neither of the foregoing undesirable features and which can be made by any engineer.

The plate shown in Fig. 1 is cut out of a piece of ⅛-inch sheet brass with the diameter *A* equal to the diameter of the indicator drum, the arm *H* extending out a distance equal to *A* and the arm *J* ¾ inch long. A ⅛-inch hole is drilled at *C* and the swivel pulley *P*, Fig. 2, is secured by riveting the post over on the under side of the plate. This pulley may be purchased from any indicator manufacturer, but the post should be just high enough so that the pulley guides the cord in the center of the band of the indicator drum when the drum is clamped by the nut *N*, Fig. 3. The bearing *F*, Fig. 2, for the plate to rotate upon, is made from a piece of ordinary 3/16-inch brass tubing, such as that used on oil pumps. A piece of this tubing, 11/16 inch long, is used and six ¼-inch slits are cut in each end; then after being placed in the hole *B*, Fig. 1, these ends are bent over so that they form a flange, as shown at *F*, Fig. 2. Care should be taken to see that the plate moves easily in this bearing after it is clamped in position. The device is now secured in place and from the hook at the end of the arm *H* an ordinary light rubber band *R* is stretched to some stationary part of the reducing motion. (I fasten it to the screw that adjusts the tension of the drum spring).

Fig. 4 illustrates the operation of this device, looking down at the top of the indicator drum. When the pawl *D* is thrown in and the drum stops, the rubber band *R* pulls the arm *H* and consequently the pulley *P* to the right to the position shown by the dotted lines *H'* and *P'*, keeping a tension on the cord at all times and winding the slack around the drum. When the pawl is disengaged, the drum spring, being stronger than the rubber band, holds the pulley in its normal position.

I have used this take-up device on several different indicators both at high and low speeds and have always found it satisfactory in every way and it will not distort the diagram nor spoil the neat appearance of the indicator.

ROSCOE I. DUNTEN.

West Hurley, N. Y.

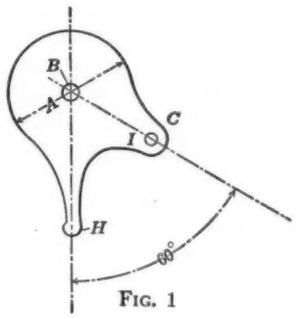


FIG. 1

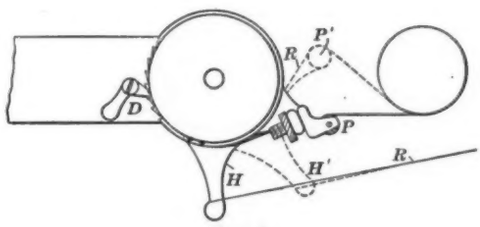


FIG. 4

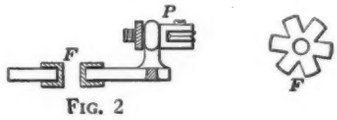


FIG. 2

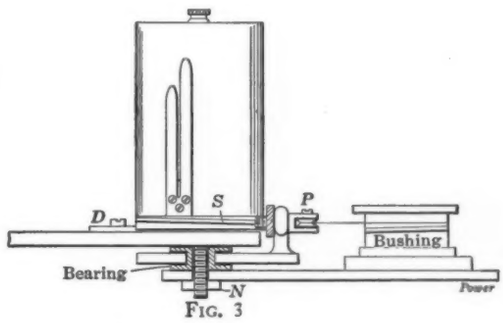


FIG. 3

DETAILS AND ASSEMBLY OF PARTS

A. V. Clayton told the Institute of Electrical Engineers last April that some 8,600,000 water horsepower are available in Sweden and Norway; there are over 7,000,000 in Japan.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Back Pressure

As R. P. Wilcox correctly states in the September 6 issue of POWER, there is much confusion regarding the term "back pressure" as applied to a heating system and to a compression refrigerating system, but his remarks seem only to add to the confusion. He says that a high back pressure or "suction pressure" in a refrigerating system helps the engine driving the compressor. He compares the engine with one driving a pump which receives its water from two tanks, one at a greater elevation than the other. When the pump receives its water under pressure, it naturally requires less power to run it than when it must "suck" the water, that is, receive it only under the pressure of the atmosphere, always providing that the speed and the discharge pressure each remain the same. But, when he asserts that the same thing is true in a compressor, he makes a mistake, as just the opposite is true. The higher the suction pressure the greater will be the power required to drive the compressor, the speed and discharge pressure remaining the same.

Let us prove this by an example. Suppose we have a single-acting ammonia compressor having no clearance, a piston one square foot in area, a 2-foot stroke and therefore a piston displacement of two cubic feet per revolution, running at 50 revolutions per minute, with a discharge pressure of 160 pounds per square inch absolute. Let us figure the power required to run the compressor first, with a "suction" or back pressure of 20 pounds per square inch absolute and then with a pressure of 40 pounds absolute. Neglect friction and assume a perfect action of the valves. In almost all ammonia compressors working on the dry-compression system, the compression is very nearly adiabatic, the cooling water in the jacket having very little influence on the shape of the compression curve of the indicator card. If we assume adiabatic compression then, according to Voorhees the mean effective pressure will be

$$M.E.P. = 4.333\, p_1 \left[\left(\frac{p_2}{p_1}\right)^{0.231} - 1\right]$$

when

p_1 = Absolute suction pressure in pounds per square inch and

p_2 = Absolute discharge pressure in pounds per square inch.

Substituting first 20 and then 40 for p_1 and 160 for p_2 and solving the equations, we find that when the "suction" pressure is 20 pounds the mean effective pressure is 53.43 pounds per square inch. When the suction pressure is 40 pounds the mean effective pressure is 65.43 pounds per square inch. This alone shows that the higher "suction" or back pressure requires the greater power, but let us see how much that will be in horsepower.

The horsepower required by a compressor is figured by the same time-honored formula used for finding the horsepower of an engine, that is,

$$H.P. = \frac{PLAN}{33{,}000}$$

When the suction pressure is 20 pounds,

$$H.P. = \frac{53.43 \times 2 \times 144 \times 50}{33{,}000} = 23.3$$

horsepower. When the "suction" pressure is 40 pounds,

$$H.P. = \frac{65.43 \times 2 \times 144 \times 50}{33{,}000} = 28.53$$

horsepower.

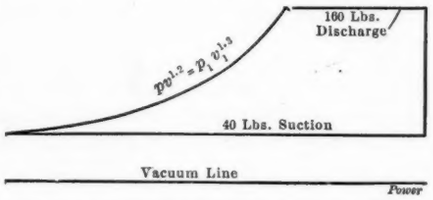


FIG. 1. DIAGRAM FOR 40 POUNDS BACK PRESSURE

In case it should not be clear why the formula for the mean effective pressure should be true, a glance at the accompanying diagrams may make things clearer. Fig. 1 is the theoretical indicator diagram for the case in which the "suction" pressure is 40 pounds per square inch absolute, and in order to show the difference more clearly, Fig. 2 was drawn for the case in which the suction pressure is 10 pounds. They are both drawn to the same scale and the compression curve in each is the adiabatic-compression curve for ammonia drawn according to the formula,

$$p v^{1.3} = p_1 v_1^{1.3}$$

A glance at them will show that the diagram for the higher "suction" pressure has the greater area and consequently the higher mean effective pressure.

If we were to reduce the suction pressure to zero, neither the suction nor the discharge valves would open and the piston would move back and forth without doing any work and without requiring any power. Then, if we were to raise the suction pressure, the mean effective pressure would also be raised. But, we know that when the suction pressure is equal to the discharge pressure, the mean effective pressure and the power required will again have fallen to zero, so we see that somewhere between the limits of zero suction pressure and the suction pressure equal to the discharge, there will be a certain "suction" pressure at which the mean effective pressure will be maximum. This can be shown to be the case when,

$$\text{Suction pressure} = \frac{\text{Discharge pressure}}{3.113}$$

From this we see that when the absolute suction pressure is higher than $\frac{1}{3.113}$ of the absolute discharge pressure, Mr. Wilcox is right and an increase in the back pressure will help the engine. But, I do not believe there are many plants that are regularly run with a suction pressure as high as that and for all lower suction pressures an increase in the back pressure requires an increase of power if the speed and the discharge pressure remain constant.

In all books on refrigeration we are advised to carry as high a back pressure as we can; but if a high back pressure takes more power, then where is the gain? The answer is simple. The refrigerating capacity of a compressor depends on the weight of ammonia gas it can take from the cooling coils and force to the condenser. In the case of the higher back pressure we have a denser and heavier gas, and the increase in the weight of the gas handled and the consequent gain in refrigeration much more than offsets the greater power required. In the first example, the compressor

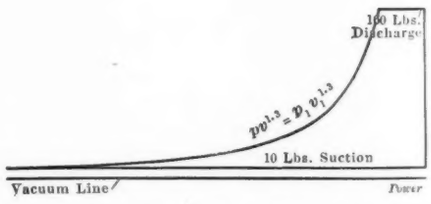


FIG. 2. DIAGRAM FOR 10 POUNDS BACK PRESSURE

handled 2 cubic feet per revolution or,

$$50 \times 2 = 100$$

cubic feet of gas per minute. According to Wood's ammonia tables, 1 cubic foot of saturated ammonia gas at 20 pounds pressure weighs 0.0744 pound and 1 cubic foot at 40 pounds pressure weighs 0.144 pound. Then, when the suction pressure is 20 pounds per square inch, the compressor handles

$$100 \times 0.0744 = 7.44$$

pounds of gas per minute with an expenditure of 23.3 horsepower or

$$\frac{7.44}{23.3} = 0.319$$

pound of gas per horsepower per minute. When the suction pressure is 40 pounds per square inch, the compressor handles,

$$\frac{100 \times 0.144}{28.53} = 0.505$$

pound of gas per minute per horsepower.

Although we come to the conclusion that a high back pressure in an ammonia-compression refrigerating system requires more power per stroke of the compressor, the total power is less because owing to the increased refrigerating capacity of the compressor the engine and compressor can be run so much slower. So, after all, a high back pressure does help the engine though the action of the gas in the compressor is in no way analogous to the action of the water in the pump.

A. E. MUELLER.

Mayville, Wis.

Verdict on Canton Explosion

In regard to the recent explosion at Canton it is my opinion that the operation of cutting in a boiler cannot be performed rapidly enough to cause waterhammer. With an ordinary gate, globe or angle valve, the opening movement is necessarily comparatively slow, and unless the operator "cracks" the valve and then spins the wheel open at a terrific speed, I do not believe that conditions ever exist in common practice under which waterhammer can take place.

If waterhammer *is* possible when a master valve is opened, even with haste, why is it not present with all its alleged destructive effects every time the safety valve blows? Where is the engineer who has not seen a boiler suddenly release a quantity of steam through the safety valve equal to its generative capacity, when, for any reason, all other outlets were wholly or partially closed? If cutting a boiler in on the line causes waterhammer, then a safety valve (especially a pop valve) will do it; and if this is so, why is it that more engineers and firemen do not take the most direct route to "Canaan"?

If waterhammer were going to take place at all, why should it wait till the master valve is two-thirds open, as was shown by the testimony at Canton? The theory advanced by John Dodd, that possibly Austin went up on the boiler to tighten the gland on the master valve just previous to the explosion is extremely probable. Valves are prone to leak badly under just such circumstances, and there is not a man in the business who has not done exactly the same thing that Mr. Dodd described.

The average coroner thinks that "what he says goes," and that the public has to accept his verdict as final, whether it is within 40 miles of the truth or not. Usually the position of coroner is passed out to some good henchman of the party in power "for services rendered," and he is elected by a huge majority, gets into the public eye, gets chesty and proceeds to render decisions in accordance with either his own conceited ideas, or those of the demagogues who put him in power.

GEORGE H. WALLACE.

Racine, Wis.

The Expansion Valve

In the August 30 number of POWER, Mr. Nash makes what seems to me to be an erroneous statement regarding the action of the liquid anhydrous ammonia in a refrigerating system when it is passing the expansion valve. He says that "Many seem to think that the valve is for the purpose of regulating the rate of expansion of the ammonia liquid; that this valve is to be opened only enough to allow the liquid to instantly flash into a vapor." Considering the promptness with which the temperatures respond to the adjustment of the expansion valve it would seem to indicate that the action as quoted is exactly what takes place. Taking for example the absorption system having a brine cooler consisting of a vertical cast-iron cylinder with interior coils through which the brine is circulated, the expansion valve, which will connect with the bottom of the cooler, will be adjusted to cause the liquid to wiredraw through it and pass in as a fine stream. The liquid being relieved of pressure will immediately vaporize and in so doing absorb heat from the surrounding brine. If the liquid is allowed to pass in faster than it will vaporize it will accumulate in the bottom of the cooler and all further control with the expansion valve is lost. The evaporation would depend on the back pressure which, from excess of vapor, would go up and with it the temperatures. That the liquid ammonia does not in ordinary operation lie in the bottom of the cooler is indicated by the fact that the brine temperature immediately goes up and the back pressure down if the valve is closed. Furthermore, if the blowdown valve in the bottom of the cooler is opened no anhydrous ammonia will pass out, although if the machine has not been making dry gas a very strong aqua solution will be obtained. If, on the other hand, the expansion valve is opened a minimum amount so that expansion takes place at the valve or in the pipe leading from it, it will frost back of the valve excessively. Of course, it would be impossible to view the action of the ammonia in the cooler, but a study of conditions obtained would indicate that the flow of the liquid is regulated by the expansion valve to keep up a given back pressure, that the ammonia instantly vaporizes, producing large quantities of gas of intense cold, which, passing up through the brine coils, produces the refrigerating effect. The gas returning is cold enough to frost the return pipe up to the absorber, and its proper adjustment is usually determined by the point to which the frosting extends.

LEWIS C. REYNOLDS.

Willard, N. Y.

Rope Drives

In his letter in the September 13 issue commenting upon my article on "The Design of Rope Drives," published in the August 16 number, Henry D. Jackson hits upon what is probably the chief point of contention in connection with the subject. The curve referred to was plotted from cotton-rope data for which the firm of T. Hart, of Blackburn, England, is the authority, and it is certain that it represents orthodox ideas on the subjects.

Since reading Mr. Jackson's letter I have consulted many textbooks and have spoken to several engineers who have installed rope drives, and I find that they agree in putting the limiting speed of ropes of any kind at about 4800 feet per minute. Above this speed it is always assumed that, owing to the effect of centrifugal force, the power it is possible to transmit commences to fall off. I am aware that Mr. Kenyon holds that this is fallacious, and as one of the principal makers of ropes his opinion must be accorded full weight. Indeed, he has at various times cited particular cases in which ropes of his manufacture were actually transmitting their full power at 7000 feet per minute. This is a difficult fact to get over, but, on the other hand, it is necessary also to give full weight to the opinions of other eminent rope makers who definitely affirm the opposite. Where experts in their particular business disagree so widely it is impossible for the ordinary engineer to judge, and I am afraid that we must content ourselves with retaining an open mind until such time as the matter is definitely cleared up one way or the other beyond dispute. Personally, I prefer in the meantime to adhere to the more general conception that the limit is somewhere below 5000 feet per minute because we know we are safe at that. So far as belt transmission is concerned we know definitely that there

is a limiting speed, but, obviously, with a rope running in a groove the problem is quite different, and Mr. Kenyon founds his contention that centrifugal force is inoperative, at any rate, up to 7000 feet per minute, upon the basis of "stiction" in the grooves. I agree with Mr. Kenyon that cotton rope should be preferable to hemp in this respect owing to its softness and tendency to cling. The C. W. Hunt Company, of New York, publishes data for hempen rope, and if these are referred to it will be seen that they put the limiting speed at about 4800 feet per minute, as, I note, does also the Plymouth Cordage Company.

FRANCIS H. DAVIES.

London, England.

Trouble with a Pumping System

I agree with Mr. Kropidlowski, in the September 20 issue, that the original trouble must have been with either the pump or pipe line as the hight of the suction and the loss of head, resulting in friction in the long length of suction pipe, does not bring the lift beyond the limit of suction. The loss of head due to friction in the suction pipe in the original layout would be

$$h = 0.062\, f \frac{L V^2}{D}$$

where f is a constant determined by experiment and which for new 4-inch cast-iron pipe is 0.0056; L is the length of the pipe in feet; V is the velocity of the water in feet per second and D is the diameter of the pipe in feet.

Assuming that there was an ordinary velocity in the suction pipe of 150 feet per minute or 2.5 feet per second, in the 920 feet of suction pipe there would be a loss of head due to friction of

$$0.062 \frac{0.0056 \times 920 \times 6.25}{0.66} = 3$$

feet. This means that the head that the pump has to overcome in order to bring the water to the pump is

$$19 + 3 = 22$$

feet, which shows that the hight of the pump is well within the limit of suction.

I would, however, criticize the discharge piping, as shown in his Fig. 2. In the first place, I fail to see why the piping was put up with so many bends. There is quite a loss of head due to friction in the extra pipe and especially since this pipe is reduced in diameter to 4 inches part of the way. If the discharge pipe were run direct from the pump to the base of the tank tower and connected to the riser with an elbow, and if the pipe were made 8 inches in diameter right up to the tank, instead of there being a frictional head of about 98 feet there would be one of about 5 feet only to overcome.

It is probable that the saving in power which would result from a change in the piping arrangement would in a short time pay for the cost of the change.

GEORGE F. ATWATER.

South Norwalk, Conn.

One or Two Boilers

In answer to Mr. Lindblade's question in POWER for September 13, I will say that he was right.

There are many reasons why two small boilers should be installed instead of a larger one. First, economy. Second, less smoke will be created with the smaller ones as the heat can be kept at a much higher degree, and with the aid of automatic steam jets and air regulation a nearly smokeless condition can be maintained. Every engineer knows that much better results can be obtained by running return-tubular boilers with a slight overload than by running them under their rated capacity. Third, if an accident happens to one boiler the other can be run while repairs are being made.

G. A. GUSTAFOON.

Chicago, Ill.

In POWER for September 13, Mr. Lindblade asks for information regarding the proper boiler installation for a school-heating plant.

I am sure that two boilers would make the best installation, because one can be cut out in the fall and spring and fuel can thereby be saved. By keeping a hotter fire under a smaller boiler it is more easy to keep the smoke down and save the washday brigade on Monday mornings.

DAN A. NICKEL.

Austin, Ill.

In answer to O. Lindblade's question in the September 13 issue regarding the choice of boilers for a school building, I would say I would install two small boilers in preference to one large one. If, for instance, he needs a boiler capacity of 500 horsepower, the installation to make is two 300-horsepower boilers, for the following reasons:

While the initial cost is more for two small boilers than for one large one, the increase in economy of coal will overbalance the difference in cost within a few years. Boilers give the best economy at normal rating or under. For this reason the two 300-horsepower boilers will give the better economy. When cleaning fires, the steam pressure can be kept constant with two boilers, for one can be worked while the other is being cleaned. In case of a breakdown and when one boiler is out to be cleaned, the other, by forcing it, will carry the load.

W. C. FISHER.

Brooklyn, N. Y.

In the issue of September 13, O. Lindblade asks, "Should One or Two Boilers be Installed?" in a heating plant in which he is interested. With only the information given in his letter this is hard to determine. It would seem that the reason for using two boilers which is advanced by him is not the strongest argument that could be put forward.

While in mild weather there might be a small saving in fuel by the use of a small boiler instead of a large one, the large boiler should need less fuel than the two small boilers in severe weather, and as long as there would be the necessity of having fires under both boilers, there would be more loss with the fires banked in both than there would be if the fire had to be kept up in only one. Whether there would be much saving would depend upon the proportion of mild to severe weather at the city mentioned.

The first cost of the two boilers with their settings and the additional piping would be more than for one boiler, and unless there was enough saving in fuel to offset this additional cost, the only reason for purchasing the two instead of one would be on account of the ability to supply heat from one if the other were out of commission for repairs. There could be at all times heat from one of the small boilers, while if the single large one had to be shut down there would be no heat at all.

While the ordinary low-pressure boiler needs repairs comparatively seldom, necessity for cutting it out may arise at a time when heat is needed and if there is only one boiler no heat can then be supplied. This, rather than the saving in fuel, should be what would decide the question. Whether it is wise to pay the extra amount for the two boilers so as to get the ability to have heat at all times depends upon how much more the two boilers would cost than the single one.

G. H. MCKELWAY.

Brooklyn, N. Y.

Referring to the article by Mr. Lindblade in the September 13 issue, entitled "Should One or Two Boilers Be Installed?" I beg to say that two boilers should be installed. As long as there are boilers there will be accidents that will require them to be shut down for repairs or cleaning, and these accidents usually happen when least expected. If two boilers are installed it will reduce the danger from a shutdown one-half. I know of two cases where one boiler was installed in school buildings. In one case the boiler became disabled and school had to be dismissed on account of cold. The other case was in an orphan school that housed 400 children. The boiler became disabled in such a manner that it required two days to make repairs. The school could not be dismissed, and it was only by quick action that the children were saved from freezing or catching severe colds.

Another reason why two boilers should

be installed is that when a boiler is out of service in cold weather and the piping gets cold, there is more or less danger from frozen pipes, and the expense of repairs in one shutdown in cold weather will more than make up for the difference in the cost of one large boiler and two small ones.

W. H. KELLER.

Austed, W. Va.

In the September 13 issue of POWER Mr. Lindblade asks which would be better, to use one large boiler or two small ones for heating a school.

In choosing the number and size of boiler units there are two things to be taken into consideration, reliability of service and efficiency of operation. In all cases where possible, it is of the utmost importance to have a boiler plant so laid out that if it is necessary to shut down a boiler for repairs or cleaning, the operation of the plant as a whole will not be interfered with. In the case under consideration it would be unthinkable to install only one boiler, for if the boiler should go out of service for any reason it would mean no heat until operation could be restored. If two boilers were installed, heat could be supplied at all times, unless both boilers should go out of service at the same time, which is highly improbable. Also, with one boiler it would only be run at its full-load capacity for a very short period of each year and the rest of the time at a fraction of its rated capacity, with a corresponding decrease in efficiency. With two boilers it would be possible to run one at full-load capacity practically all of the time; and when the weather required the use of both boilers, they would never be running at less than 50 per cent. of their rated load and often nearer full load.

W. L. DURAND.

Washington, D. C.

Position of Throttle

In the issue of September 20 are a short article and a picture of a Corliss cylinder setting forth the supposed advantages of placing the throttle valve with the stem and wheel extending diagonally over the corner of the cylinder and apparently far beyond the head-end valve gear. The article states that, "It is certainly easier to handle the valve gear with a throttle of this design than if it were of the short type," etc. I disagree, claiming that it is very inconvenient and the engineer will get many a bump by rising up against the wheel which is in the way, for it is at this point that the engineer must stand to handle the starting bars. It has been my experience that nearly all engines of over 150 horsepower are fitted with a bypass around the throttle and on large engines, up to 56-inch stroke, with a quick-opening valve the lever of which is in a convenient position to reach, usually near the side of the cylinder jacket and back of the wristplate and about parallel with the main throttle stem on the type of engine shown. This valve is used in warming up and stopping or moving the engine part of a stroke.

In stopping, the main valve is closed tight; then, as the engine slows down, the reach rods are unhooked, the hand levers put in and the bypass operated to admit steam as required to stop the engine in the proper position.

Imagine opening an 8- or 10-inch valve or even a 6-inch on the end of a long stem with one hand, while the other one is busy with the bars, and admitting a little steam to block the piston to keep the crank off the center and then closing it tight and quickly enough to keep the engine from making a revolution or two the other way. If it looks easy, try it and you will know differently.

The proper place for the throttle-valve stem on a Corliss engine (horizontal) is at the side of the cylinder and with the wheel just inside of the wristplate with the bypass back of and parallel to it, the bypass being on the side of the cylinder toward the head end.

J. CASE.

Hyattsville, Md.

Trouble with the Belt

In connection with the belt-drive problem presented by Mr. Hamill in the September 27 issue, I offer the following suggestions:

There seems to be no reason why the method proposed cannot be used unless the shafts are located exceptionally close together and the belt is therefore very short. In order to guide the belt to prevent it from running off the pulley, the idler should be placed close to the driven pulley and in this position it should keep the belt on and at the same time not be near enough to the cross to cause any troublesome friction. It would not be practicable to use a cone pulley for the idler because different points on its surface would have different peripheral speeds while the speed of the belt is, of course, uniform over its entire width. This would cause friction between the belt and the guiding pulley and probably result in more trouble than if no idler were used.

If the belt is tipped at the point where the guiding pulley is applied, the difficulty may be overcome by tipping the idler—that is, setting it at an angle—to correspond to the angle of the belt. The belt may then be guided by adjusting the idler to tighten it on the side toward which it should run. The belt will run toward the tight side, following the principle that a belt always climbs to the largest diameter of its pulley.

In case the pulleys are too close together to use an idler, a fork or other device used for guiding might be employed. The chief objection to this is that the edge of the belt running against a fixed guide is very liable to become worn by the constant rubbing, especially if much power is transmitted. For an 8-inch belt running on 48-inch pulleys having a speed of 400 revolutions per minute, the guiding pulley or idler would probably be more satisfactory.

S. HURLEY.

Scranton, Penn.

License Laws

Judging from his letter in the September 27 issue, I do not look at this subject in the same light as Mr. Nigh does. I believe that every State should have license laws. They not only make an engineer get down to business but also make him a better man for the position he holds and qualify him to secure a more responsible and better paying one. They also serve to put the "would-be" engineer out of the licensed man's way.

I not only believe that each State should have a good license law but also a good law for boiler inspection.

It is true, as some say, the license does not seem to reduce the number of explosions of boilers. Usually the blame falls unjustly on the shoulders of the engineer. Often he gets killed in the explosion and is not able to tell what he told his superior about the condition of the boiler. The engineer is blamed and thus, indirectly at least, the license laws are held to be deficient. In reality the inspection law or the lack of one is the cause for the bad conditions.

If every State had a good inspection law and good inspectors, I guess some of the boiler owners would have to sit up and take notice. Conditions about the plant would probably be improved and in this way things would be better and safer for the men.

A man I know once worked for a firm which owned some boilers that were in rather bad shape. He told the superintendent that new boilers should be installed. The latter inquired why the engineer thought that the boilers were not good; they had been in service *only twenty-five years*. The engineer said that when he started to calk the leaky girth seam of one, the leak spread, showing that many of the rivets were not holding properly. The engineer was instructed to calk that seam. He did; he made the seam tight and then quit his job. A few weeks later one of the boilers moved and moved with it everything that was in its path. It moved the south wall and part of the east wall of a four-story brick building right out onto the railroad tracks. The damage amounted to about $15,000. The engineer held a license and did his part. He warned the owners of the danger. Decidedly, the license law was in no way to blame for that disaster.

CLINTON MILLER.

Covington, O.

Reducing the Labor Cost in a Plant

Under the old system the ashes were dumped into the cellar, from which they had to be shoveled up to the street level and carted away at a cost of $1.50 per wagon load. By the installation of an ash elevator this figure was greatly reduced.

Every owner of a power plant is interested in the reduction of the operating expenses and it behooves the engineer to discover a method of effecting the reduction. If the cost of handling the coal is reduced to the minimum, an economical method of disposing of the ashes should next receive attention. There are certain seasons in the year when the ashes may be disposed of at a profit, but during the winter months usually the ashes are an expense and the labor in handling them is quite an item. In some localities quantities of ashes are consumed in cement pavements, as well as for fireproofing and concreting. In other places, they are simply used for filling in, or are wheeled out on a dump and in the spring are carted away.

pavement, adjoining the boiler room. Owing to the storage capacity being limited, they were obliged to employ two extra men with a wagon to remove these ashes at a cost of $1.50 per wagon load. After a period of time, it was discovered that this method was particularly crude and very inconvenient; one man was usually stationed in the cellar, shoveling the ashes through a manhole into the roadway overhead, while the other man was obliged to shovel the ashes into a wagon from the alley pavement. The process of hand shoveling was, therefore, a double one as the ashes had to be hauled away by a wagon.

The company grew tired of this unprogressive arrangement and decided to install a conveying system. Fig. 1 shows the method adopted for handling these ashes. A Jeffrey bucket elevator slightly over 23 feet between centers was used, consisting of a chain with 32 malleable-iron buckets and provided with a con-

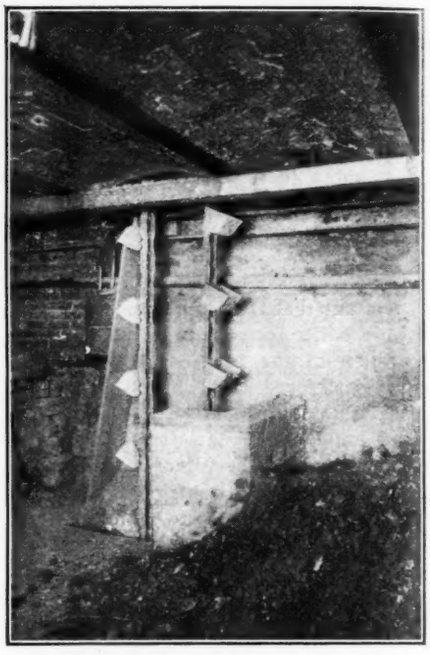


FIG. 2. CONVEYER INSTALLED IN CELLAR

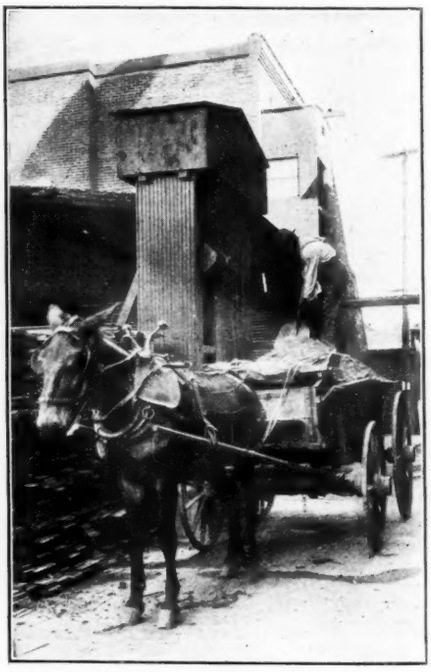


FIG. 3. METHOD OF CHUTING ASHES INTO WAGON

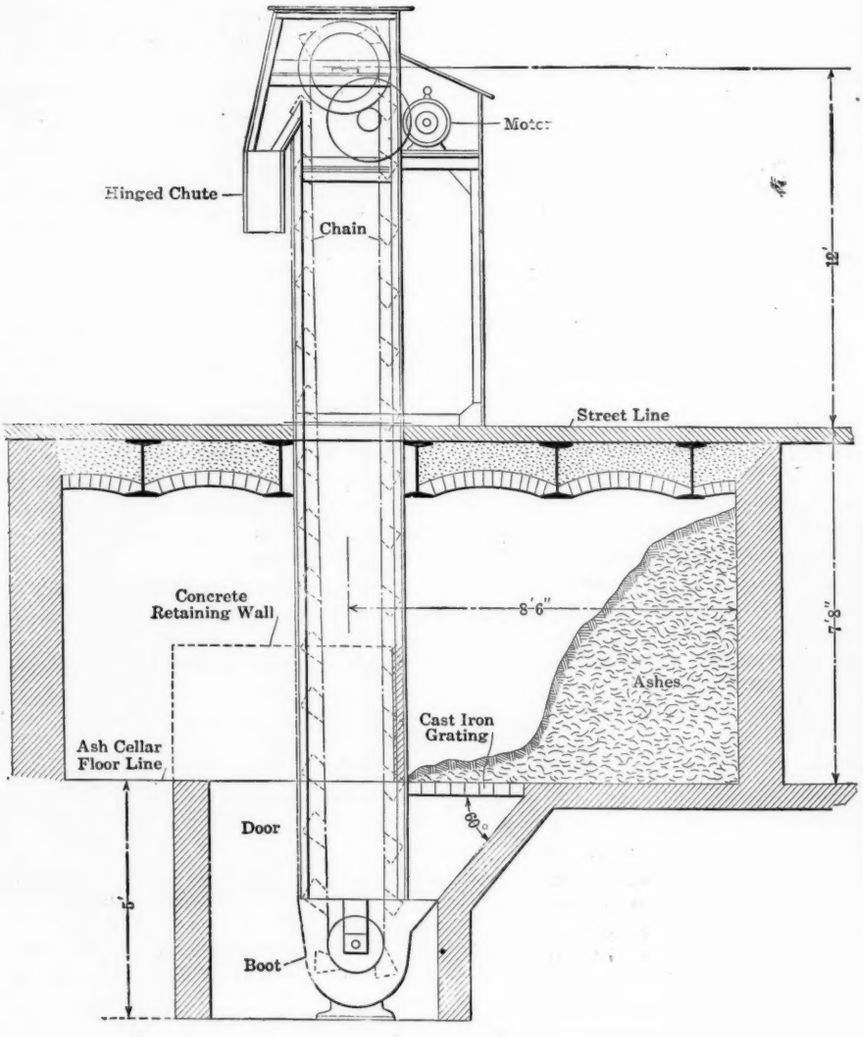


FIG. 1. COMPLETE LAYOUT OF THE CONVEYER

crete boot, or "loading leg," on a level with the floor line of the ash cellar. This boot is provided with a cast-iron grating which prevents large clinkers from entering the elevator and choking it. These clinkers are cast aside and broken up, after which they are delivered to the elevator. The latter is driven through spur gearing by a 3-horsepower electric motor.

Fig. 2 is a reproduction of a flash-light photograph of the cellar; a brick wall having been constructed around one side of the conveyer to enable the ashes to be piled up.

Fig. 3 shows the method of chuting the ashes directly into the wagon. The chute is hinged, which arrangement allows it to be dropped out of the way on account of the narrow passageway. The elevator has a capacity of loading 5 cubic yards of ashes in less than 20 minutes.

The Street Railway Question Box

The question box of the American Street and Interurban Railway Engineering Association contains some items of interest to POWER readers.

What increase in fuel economy have you been able to accomplish under regular operating conditions? Upon what bonus, or premium, if any, has this been based?

In the six answers received there is not a bonus. All but one have been able to make some increase in their fuel economy, one 8 per cent. by the use of a "fine shaking grate," one 5 per cent. by "improving boiler conditions," and the others unspecified amounts by attention to details in the boiler room. One lays much of the advantage gained to the use of recording gages wherever possible; and one to purchasing the coal under specifications in which is inserted penalty for furnishing poor coal and bonus given for furnishing good coal. The specification is based on B.t.u., percentage of ash, sulphur and moisture.

Is the use of boiler compounds to be avoided if possible? Why?

Of the eleven answers received to this question four favor the use of compound, and are evidently inspired by favorable experience with it. Five advise against the use of compound "because of its deteriorating effect on steel in the boilers," "because of expense and danger of foaming," "on account of its pitting the tubes" and "because of unnecessary expense." The wording of the question invites an affirmative answer, for naturally anything which involves trouble and expense, and the use of which may lead to second troubles is, of course, to be avoided *if possible;* that is, if its avoidance does not involve greater expense and trouble than its use will save and prevent. One respondent says that "the use of boiler compound should be avoided if possible, but if necessary to use same, care should be taken not to use any more than is absolutely necessary. Practically all boiler compounds will attack the packing in the stuffing boxes, on the steam valves and joints on steam mains. In some plants where economizers are used it will attack the caps and joints, starting them to leaking. Where it is necessary to use compound in large quantities on account of the condition of the feed water, I have noticed that the compound has affected the walls and piston in the cylinders and caused what is commonly called 'grooving.' Therefore, there are many reasons why boiler compounds should not be used, but in a large number of plants the condition of the feed water is such that the use of compounds cannot be avoided, as it will prevent the formation of scale in the boilers to a certain extent."

Attention is paid to a number of practical questions such as Fuel Economy from Bonus System, Use of Boiler Compounds, Lignite Coal as Fuel, Flywheel Insurance, Forced Draft with Chain Grate Stokers, etc.

Still another says that "the use of compounds should be avoided if the water is such that you can do so. Otherwise, the very highest grade boiler compound should be used, because poor quality may cause steam pipes to eat through and may damage cylinders." He has tried many kinds and found one which meets his case and keeps his boilers in good condition.

What is the nature of tests commonly applied at the boiler rooms of member companies by insurance inspectors as a basis for certificates guaranteeing safe working pressure on boilers?

The nine replies to this question simply brought out the fact that the hammer test is ordinarily used and that the inspection is circumstantial and thorough.

Have you ever used lignite coal? If so, what is your opinion of it as a fuel?

Of the nine answers to this question one, from Texas, says that lignite compares favorably with any other kind of fuel. The other eight simply assert that the writers have never used lignite.

How can the air space between the bridgewall and grate bars of a chain-grate stoker be automatically stopped or reduced in area?

H. Gilliam, electrical superintendent, New York, New Haven & Hartford Railroad Company, says: "As far as I know there are two types of chain-grate stokers, the incline and the level type. The incline type generally has a stationary dump grate attached to the back wall. The other type generally uses overhanging bridgewalls. The area can be adjusted by moving the grate closer or farther away from the back wall, as the chain-grate stokers are mounted on a truck. I do not know of any automatic device that will make this change."

W. A. House, president United Railways and Electric Company, of Baltimore, writes: "Adjust the distance between the rear end of stoker and bridgewall so that the required thickness of fire may be carried without allowing the ashes to bank up or fall off, leaving an open space.

Can forced draft be used on a chain-grate stoker? If so, how, how?

The replies generally favor the use of induced draft, although some of the respondents think that forced draft can be used if provision is made for stopping the air space at the end of the grate.

Is it good practice to operate large flywheel engines of a reputable make without flywheel insurance?

Of the nine answers to this question four favor flywheel insurance; the other five assume that accidents will happen anyhow and that the risk is of the same order as that of loss by earthquakes, torpedo or floods. One insists, however, that the flywheel should be properly inspected at certain intervals, "say four times a year."

What should be the cost per 100 *kilowatt-hours for lubricating the high- and low-pressure cylinders of a* 1650-*kilowatt vertical cross-compound condensing engine, operating, at full load,* 75 *revolutions per minute, saturated steam,* 150 *pounds pressure and* 25 *inches vacuum?*

The three replies to this question show a remarkable agreement, although coming from widely different parts of the country. One from St. Louis fixes the figure at 0.32 cent, one from Baltimore at 0.30 cent, with oil at 30 cents per gallon, and one from Louisville, Ky., at 0.50 cent, with 50-cent cylinder oil for the high-pressure cylinder and 25-cent oil for the low.

Do you use a damper regulator? If so, is there any way to prevent smoke when the damper is closed?

There seems to have been some confusion as to whether this question referred to smoke coming out into the fire room, or smoke at the chimney due to insufficient air supply.

Of the ten members responding to this question four do not use damper regulators, but that used by another "pays for itself in three months' time." The

general recommendation is to so adjust the chains, or so provide in the installing of the damper that it cannot close off completely, nor sufficiently to prevent the minimum draft required.

What is your experience with and your estimation of the value of grooving commutators to date?

Of the twenty replies received seventeen are favorable to the use of the grooved commutator. Two members confessed to no experience and one has had very good success with large motors which have good protection from dust, but on small motors has had trouble from oil and carbon dust. Several of the respondents are enthusiastic in its favor, crediting it with the saving of at least half the cost and maintenance of commutators and brushes, one in particular saying that "commutators can be grooved at a cost of not over 10 cents per commutator, and the grooving increases the life of the commutator from 100 to 150 per cent., as well as increasing the life of the brush by about 40 per cent."

What are the causes of broken brushes on 101-B motor and remedy?

The responses generally lay the trouble to high mica and inferior brushes, and advise the grooving of the commutators and the use of high-grade brushes, not too brittle. One says that "The probable cause for the broken brushes on the Westinghouse 101-B motor is the absence of shunts ['pigtails'] on the brush-holders, which produces an undue wear in the brush slots, and in turn such undue movement is given to the brush as leads to its being rapidly broken. The remedy is to see that the brush-holders are equipped with proper shunts and these maintained with good firm contact." Another advises the use of two brushes per holder in place of one.

Forced Draft and Boiler Economy*

By C. E. Roehl

The limitations of forced draft and its bearing upon the capacity and efficiency of boilers are discussed together with the personal equation of the fireman.

Draft, as used in its most general sense, as air supplied for combustion under steam boilers, may be obtained naturally by high stacks or artificially by a blowing apparatus. Artificially it may be produced by a reduction in pressure above the fire or by an increase in pressure below the fire; the former is usually termed induced draft, and the latter forced draft. It is in this sense that the phrase forced draft is used in the following discussion. Artificial draft is used for obtaining capacity above the normal with ordinary fuel or for securing a satisfactory capacity with low-grade fuel.

Induced draft may be regarded as a substitute for natural draft, instead of using prohibitively high stacks; but this is not true of forced draft. In viewing the relation of forced draft to high stacks it should be recognized that where low-grade fuel is used forced draft is a necessity. Where low-grade fuel means anthracite screenings, forced draft cannot be looked upon as one of two equally efficacious forms of artificial draft substituted for natural draft with high stacks, but possesses an inherent advantage over induced draft. This lies in its ability to cope with the packing of fuel on the grate, whereby great resistance is offered to the passage of air. A fuel bed of anthracite screenings, even when actively burning, offers far greater resistance to the passage of air than the walls of air ducts and ashpit connections. Each particle of coal is struck by the air currents and is moved around in layers near the grate before the air passes through the bed sufficiently to reach the incandescent particles for oxidation. This shifting of the individual particles of coal, which may be slight, moderate, or excessive, depending upon the air pressure, does much to break up the otherwise abnormally high resistance of the fuel bed. When excessive, the coal is blown from the grate and much of it is kept dancing in the furnace, sometimes to a hight of two feet. In induced draft this lowering of the fuel-bed resistance does not occur. As the ashpits are always open to the atmosphere the energy of the air beneath the fire is exclusively in potential form, save for the very moderate velocity.

Conditions Governing Capacity

Fundamentally, capacity is merely a matter of rate of firing which varies widely, whereas efficiencies with a given grade of fuel do not vary. Therefore, it follows that it is necessary only to put coal into a furnace and burn it to cause the rate of steaming to vary nearly in proportion to the rate of firing. This practical response of the rate of steaming to the rate of firing follows logically from the modern recognition that the limitation of the heat-transmitting ability of the heating surfaces is not approached. In large power stations much attention can well be given, in an effort to advance the present standard, to studies of the relation of rapid firing by one man in charge of a moderate grate area as against moderately slow firing of a large grate area represented in practice by having one man fire many furnaces.

Relation between Capacity and Efficiency

With low-grade fuel, forced draft nearly always secures increased efficiency, the efficiency increasing with the capacity within the limits of possible combustion. This appears to be strictly true when the heating surface alone is concerned. At very high combustion rates the furnace efficiency is apt to fall sufficiently to offset the rising boiler efficiency. This, however, under proper conditions of control occurs only near the upper limit of the usual attempts at forcing and as efficiency is not a ruling factor when forcing is necessary this is not of importance.

Higher steaming capacity usually reduces labor charges and inevitably reduces investment charges. It is true that maintenance charges increase, but these are confined to the furnace and, except in very special cases, while an offsetting factor, it is not a ruling one.

In considering air pressure and its relation to capacity and efficiency, one of the most serious limiting factors, in what otherwise appears a field where the higher the pressure the higher the overall station efficiency, is the blowing of coal from the grate after a critical pressure has been exceeded. Very fine coal is not only blown from the grate, which would be no serious matter if it came down again, but is blown over the bridge-wall, and in some cases is blown in considerable quantities through the heating passes and into the flues. The economic loss is not often serious, but in cities the trouble and expense may be considerable. Another limiting condition is the inability of the lower water tubes to stand the severe demands which may be made upon them. While it is probable that the capacity of the tubes to absorb practically unlimited quantities of heat may be counted upon, it is not true that this capacity is unaffected by the temperature at which the heat is delivered to the tubes of the lower row, and even of the second and third rows. This seems to be a limitation particularly concerned with high combustion rates secured with forced draft. When forced draft is used with very small-sized coal and a high average combustion rate is being maintained, it is practically impossible to avoid spots where for a time the combustion rate

*From the report of the committee on "Power Generation," of the American Street and Interurban Railway Engineering Association.

becomes extremely high. Blasts of gas of intense incandescence are delivered, which, while not notably increasing the total heat delivered from the entire grate to the heating surface, cause the endurance of isolated sections of the tubes in the lower rows to be severely tested. The approach to the safe limit of endurance of the metal is probably not a matter of approaching its limit of thermal transmitting ability but of the failure of the water-circulating arrangements to provide properly for heat absorption. It is not unlikely that in the trend of boiler modification which will come about to meet the approaching demand for higher steaming rates this matter of circulation will receive large attention. Another limiting feature against higher air pressure for the realization of higher capacity is the increased cost of the air supply at extremely high pressures. However, a moderate increase of 100 or 150 per cent. over the present nominal evaporating rate of 3.45 pounds of water per hour per square foot of heating surface from and at 212 degrees Fahrenheit must be brought about. The installation of very large turbines has forced this and in isolated instances much has already been accomplished.

Conditions Governing Efficiency

In railway power-plant work, forced draft must be adapted to varying steaming rates. The maintenance of steam pressures just slightly below the setting of the safety valves is the desideratum, and as the fluctuations in the steaming demand are large in relation to the steam-storage capacity of water-tube boilers, the adaptation of the forced-draft system to varying rates must be accurate and prompt. Steaming rates are varied, of course, only by a variation in the combustion rates. Efficiency, therefore, demands that the forced-draft system be adapted to permit variation of the combustion rate over wide ranges and this requires variation of the air pressure. Although a variation of air pressure will cause a variation in the rate of combustion of the coal already in the furnace, it will do no more. Therefore, the problem is, where hand labor is concerned (and this alone is considered as high air pressures are not commonly used with automatic stokers), to cause the firemen to vary their rate of firing to meet the varying rate of combustion. This is the crucial problem in the attainment of a high efficiency.

In many cases the quality of the labor is most unfavorable, lacking individuality in the relation of the man to the boiler. The labor, while reasonably well paid, is largely foreign labor and not infrequently is low in intelligence, thereby excluding the skill which in isolated-plant work is sometimes of sufficient merit to make firing approach the level of a skilled trade. In addition to the other handicaps rapid changes in the personnel are not rare.

A few years ago great interest was aroused by the development of automatic CO_2 recorders, but the hopes which this development aroused as to a solution of the problem of high efficiency have not been realized. More light is at present available on the cause of the disappointment than was available after the CO_2 recorders had been in use sufficiently to make the disappointment evident. This concerns the relation between gas velocities and the thermal transmitting ability of the heating surface. The efficiency of the combustion, as measured by the percentage of CO_2, is not the ruling criterion of overall efficiency nor of boiler efficiency separated from furnace efficiency, because a high percentage of CO_2 with unchanged combustion reduces the gas velocity across the heating surfaces, which is an offsetting factor. This reduction of velocity with the accompanying deleterious effect on the thermal transmission coefficient probably explains the practically invariable rise of flue temperature with increased CO_2.

The same strictures may be made against the somewhat extensively exploited balanced-draft systems. Unquestionably they at once gave very high CO_2 values. The claims of their sponsors in this respect were not exaggerated. Necessarily used only in conjunction with forced-draft systems, they involved the danger of flare-backs from the furnace doors, and aside from this they raised the furnace temperature so high that the tax on the firemen was severe.

It has been recognized that high CO_2 values, which are very readily obtained with forced-draft systems, may easily become too high, and these are a direct measure of the furnace temperature. Before the research work of the United States Geological Survey and others had made it evident that the highest CO_2 values did not correspond with the highest efficiencies, the best practice had settled down to ruling against more than 12 to 13 per cent. of CO_2.

The problem of handling forced-draft systems efficiently in railway power-plant service reverts to that of procuring firemen to fire well at the varying rates which are demanded by the varying load. The general tendency of poor firemen is to throw so much coal in one door without stopping, that a long interval elapses before the firing operation is repeated. A general corrective expedient for this, and one which is decidedly practicable, is the limitation of the number of shovelfuls permitted to be fired in any one door without stopping. This number may be six or eight, preferably six, and, although forming no limitation to the rate of firing, it at once goes a long way toward establishing the practice of light, thin fires as against heavy thick ones. Equally, if not more important than thin fires, is the correct adaptation of the firing rate to the draft, or in more specific terms, the ashpit or air-duct pressure. With a 1-inch air pressure in the duct, should the rate of firing with a given grade of coal and boiler equipment be 16 or 20 pounds per hour per square foot of grate surface, or some other rate? On the answer to this the resulting economy of the evaporation apparently hinges. The individual fireman of the order found in large power plants cannot be expected to answer this himself or, in fact, to know anything about it. Extensive experimental work appears to show that the error is sometimes on one side and sometimes on the other, but that with a given fuel and boiler equipment there is a definite relation between air pressure and rate of firing, which gives the best evaporative economy over wide ranges of steaming. Differential gages reading to 0.01 inch of water have been tried and are accurate and reliable but the difficulty is to devise a simple system for their use.

The problems which in their solution will probably mark the most significant advance in forced-draft practice appear to be the better proportioning of air ducts and sealed ashpits, particularly the intakes of the latter from the former, as now large losses of pressure are frequent; the modification of furnaces and boilers to allow the use of higher pressures and gas velocities which are necessary for the utilization of more intense evaporative rates; and the development of a simpler means for the control of the efficiency, which leaves at present more to be done in the way of controlling the firing than in controlling the air pressure or draft. It is hard to say whether the second of the problems, that of controlling the capacity, or the third, that of controlling the efficiency, is the more important.

Old Pete Blowoff sez he kin run his ingin on less cylinder ile than any ingineer in th' kentry. Pete never fills his lubricater 'cept when he aint full hisself, an' thet accounts fer it.

Th' humane sassiety hed Pete arrested fer runnin' his ingin when it was groanin'. Pete swore thet it wasn't sufferin' any but thet it hed th' heaves on account uv burnin' dusty coal.

Pete went up t' get license tother day. Th' inspecter feller ast him what he'd do ef he opened his furnis door an' seen th' bottom uv his biler red hot an' comin' down on th' grates.

Pete told him he'd drop th' shovel an' run like h—l. Th' inspecter sed "kerrect," an' give him a fust-class license.

I've noticed thet it aint always th' man thet kin shoot off th' most hot air 'bout algebray, triggernomerty, an' sich thet has th' best runnin' ingin, by a dum sight.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Size of Condensing Chamber

What is the rule for finding the size of the condensing chamber of jet condensers?

S. C. C.

The chamber should be large enough to provide for the thorough intermingling of the steam and water. The opinions of designers vary and the proportions range from a slight reduction in the size of the exhaust pipe to a chamber about four times the diameter of the pipe.

Lap for Given Cutoff

How can I find out how much lap to give a slide valve to cut off at one-half stroke?

L. G. C.

Multiply the valve travel in inches by 0.354.

Cushion by Lead

How much lead shall I give the valve of a 12x20-inch engine running 175 revolutions per minute to cushion the piston at the end of the stroke?

C. B. L.

None. Steam admitted to the cylinder in front of the advancing piston will not cushion it but will have the reverse effect. Compression alone will furnish the cushion needed, and may be increased without altering the lead by adding to the inside lap of the valve.

Flow of Air through Orifice

How can I determine how many cubic feet of air will be lost through a hole in a pipe or hose, the pressure and the size of the hole being known?

P. T. O.

The formula for the theoretical discharge is

$$V = A \times 37.8 \sqrt{P \times P'}$$

in which

V = Cubic feet of free air discharged per minute;
A = Area of orifice in square inches;
P = Absolute pressure in pounds per square inch in the pipe;
P' = Difference in pressure between the inside and the outside of the pipe.

The actual discharge for pressures in the neighborhood of 80 pounds per square inch will probably be 70 per cent. of the theoretical.

Submerged Hydraulic Ram

Can a hydraulic ram be made to operate if submerged?

J. W. L.

As the operation of the ram depends upon the velocity of the flow of the escaping water and as submergence will decrease the velocity of the flow, it may be seen that only a slight depth of submergence will render it inoperative.

Thermometer in Condenser

Of what use is a thermometer in a condenser?

T. I. C.

Knowing the temperature in the condenser may lead to the detection of the cause of insufficient vacuum. A high temperature indicates too little cooling water and a low temperature accompanied by poor vacuum indicates air leaks.

Compressor Discharge Valve Area

What is considered good practice in proportioning the relative areas of the valves and pistons of high-speed air compressors?

C. D. A.

Modern practice for piston speeds ranging from 500 to 700 feet per minute dictates that the effective area of the discharge-valve opening shall be 15 to 25 per cent. that of the piston and that the inlet-valve area shall be the same, if possible.

Wire Drawing Defined

What is the meaning of the term "wire drawing" when applied to steam, and how does it act?

W. D. D.

Steam is said to be wire drawn when it is passed from a region of one pressure to that of a lower through a restricted opening, as in the use of a throttling-governor valve, a pressure-reducing valve, a partially opened valve or cock, etc. It is said to be superheated because in passing to the region of lower pressure it parts with little or no heat and has the temperature of the higher pressure. Wire drawing causes no change in its attributes.

Grunting Feed Pump

I have a double-acting feed pump supplying hot water from exhaust tank and heater to boiler. This pump sets up a loud grunting noise at almost every stroke. What is the cause and how can I remedy it?

K. M.

The first thing to do is to determine whether the noise comes from the steam or water cylinders. If from the steam end, the lubrication is inefficient. If it comes from the water end, the packing is too tight and should be loosened.

Difference between Steam and Vacuum Gages

What is the difference between a steam gage and a vacuum gage?

D. S. G.

None, except the graduations on the dial and the purposes for which they are used. Each is used to indicate the difference in pressure existing between the outside and inside of the spring tube of the instrument. When used to indicate pressures below that of the atmosphere it is called a vacuum gage.

Safe Working Pressure

Please give me the rule for figuring the safe working pressure of a steel boiler 7/16 material, butt-strap joint, 72 inches diameter using the factor 5 for safety.

H. H. S.

The working pressure of boiler shells is calculated by the formula

$$\frac{T.S. \times t \times \%}{R \times F.S.} = \textit{Working pressure per square inch}$$

in which

$T.S.$ = Tensile strength of plate in pounds per square inch of cross-section;
t = Thickness of plate in inches;
$\%$ = Efficiency of joint;
R = Inside radius of outside course of shell;
$F.S.$ = Factor of safety.

As the tensile strength and the efficiency of the joint are lacking in the question they are assumed to be 60,000 pounds and 87 per cent. respectively.

Then,

$$\frac{60{,}000 \times 0.4375 \times 0.87}{36 \times 5} = 127$$

pounds per square inch.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.
150 Michigan Avenue, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1909 *we printed and circulated* 1,875,000 *copies of* POWER.

Our circulation for September, 1910, *was* 134,000.

October 4	33,000
October 11	33,000
October 18	33,000
October 25	33,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
The Works of Escher Wyss & Co	1882
Development of the Blowoff Valve	1886
The Absorption Refrigerating System	1888
A Boiler Explosion in Hungary	1891
The Cost of Heat, Light and Power	1892
Packing and Junk Rings	1895
Significant Figures for Engineers	1896
Moisture and Impurities in Transformer Oil	1897
Single-phase Traction in France	1898
Too Much Bolt and Washer	1898
Polarity Indicators	1899
A Novel Wiring Conduit	1899
Another Circuit Breaker Alarm	1899
Humming Armature Cores	1899
Developments at the Deutz Gas Engine Works	1900
Efficient Gas Cleansing	1900
Accident Due to Careless Governor Construction	1901
Lloyd's Rules for Marine Engineers	1901
Setting Small Engines	1902
A Lucky Escape	1902
Practical Letters: Thermometers versus Gages .... Why Are There Not More Writers among Engineers? .... The Engineer Proved That He Was onto His Job....Separating Water from Oil ....Device for Taking Up Slack in Indicator Cord	1903-1905
Discussion Letters: Back Pressure....Verdict on Canton Explosion .... The Expansion Valve....Rope Drives .... Trouble with a Pumping System....One or Two Boilers....Position of Throttle....Trouble with the Belt.... License Laws	1906-1909
Reducing the Labor Cost in a Plant	1910
The Street Railway Question Box	1911
Forced Draft and Boiler Economy	1912
Editorials	1915-1916

Power and The Engineer

Editorial

Safe Boiler Appliances

There are four essential adjuncts to a boiler that are necessary for its safe operation; namely, a blowoff valve, safety valve, water columns and gage glass and steam-pressure gage. All of these devices are shamefully abused in many small steam plants, and if the truth were known the same criticism might be applied to a good many large plants as well.

The safety valve is generally left to take care of itself, if it will but operate when the steam pressure reaches a certain predetermined point. The blowoff valve is often allowed to leak so long as it does not lower the water in the boiler enough to cause trouble. The water column and steam gage are the two safety factors which require watching, and yet they are often the ones most neglected.

On vertical boilers the water glass is frequently so poorly illuminated that even an expert could not tell to a certainty the exact location of the water level. Under such circumstances the boiler attendant depends upon the high- and low-water alarm and this device is frequently heard operating in many steam plants, which is a reflection upon the method of handling the plant.

A good engineer or chief fireman will keep the water glass on each boiler under his charge clean, both inside and outside, and a light properly placed so that the watertender or fireman can readily see the water level from various points of view.

The proper method of determining the water level in a boiler is to try the gage cock and not to depend upon the water glass. There are few firemen, however, who do not place almost implicit trust in the water glass; hence it should be kept clean and in proper working condition.

The pressure gage is by no means of secondary importance and yet few register correctly after a few years' use. Frequently the face is so dirty or the gage is so located that it is almost impossible to read the steam pressure. This is, of course, bad engineering and should never be countenanced by an engineer.

Placing a steam gage at a distance from the boiler is not good practice, because the long pipe is almost certain to become clogged with sediment. Connecting the steam gage to the metal front of a boiler, where heat from the boiler setting is transmitted to the gage, is a practice not to be commended.

A false steam gage is a dangerous thing and if it and the safety valve are both defective at the same time, a boiler to which they are attached is as dangerous as a bomb with a lighted fuse. Nevertheless, there are a large number of boilers operating under just such conditions. How about yours?

Of course, there is but one way to obtain safe operation of a steam boiler and that is to keep everything connected with its operation in the best of condition, first, last and all of the time.

The Operator and the Boiler Manufacturer

There are no two classes of people who should have more interests in common than the men who operate steam boilers and those who make them. The manufacturer is interested in making a good boiler to maintain his reputation, while the engineer is interested in having sound boilers to operate because his life depends on it. For twenty-two years the American Boiler Manufacturers' Association has stood for better material, better workmanship and methods and consequent greater safety in steam-boiler operation. One of the objects of the organization is the adoption of a standard set of specifications for boilers, so that a boiler built in one State will be accepted as safe in any other State, which is decidedly not the case at present. If a man wants to buy a boiler for a steam launch he can buy of any boilermaker and know that the boiler will be as good as high quality, material, workmanship and inspection can make it, because the boilermaker must take his plans to the proper Government authorities and prove that the sheets are strong enough, that the stays are adequate and properly spaced and that the general design is in keeping with the service the boiler will be called upon to perform. After the plans have been approved, the construction will proceed under competent inspection, and when finished the job will be a credit to the maker.

If the same man wants to buy a boiler for his office building he has only to specify the capacity required and then out of those offered take the cheapest, regardless of quality of steel, workmanship or suitability for the conditions. This is something which should be corrected

and which the association is working for. While the subject of materials and workmanship occupies the attention of the makers, discussions among operating engineers are almost exclusively on methods of handling to avoid accident. The two questions go hand in hand and there is unlimited opportunity for coöperation if the work is carried on in the right spirit.

The National Association of Stationary Engineers should have a representative at every meeting of the Boiler Manufacturers' Association and should lend its influence wherever possible to bettering the quality of material entering into steam boilers, equalizing the boiler regulations throughout the country and raising the standard both of construction and operation.

Gas Power and the Engineer

In a well equipped steam plant, operating condensing and containing all the refinements which tend toward economy, the ultimate efficiency depends upon the combination of a number of factors, including the boilers, engines, steam piping, condensers and other auxiliaries, as well as the coal and the care exercised in firing. With all these operating at their best, the highest thermal efficiency thus far attainable has been only about fifteen per cent.; and this has been possible only where a steam turbine or a compound Corliss engine was employed. Of the eighty-five per cent. of the energy in the coal which is unutilized, some passes up the stack both as sensible heat and as heat in unburned gases, and some is lost by radiation, but perhaps the greatest loss may be attributed to the inability of the steam engine to utilize all of the energy contained in the steam. Expressing these facts in a more concrete form, it may be said that for every ton of coal costing three dollars, only forty-five cents' worth of energy is converted into useful work.

In view of this relatively low efficiency of the steam plant it is somewhat surprising that the gas engine and gas producer have not come into more general use for medium-sized plants in this country. For with a gas engine and producer, a thermal efficiency about double that of the steam plant is attainable; that is, for a pound of a given coal twice as much useful work can be obtained. Moreover, low-grade coals may be used to advantage in a producer. The fact that the gas engine in relatively large units is a recent development, and the consequent lack of knowledge regarding it on the part of buyers and operators, may account largely for the slowness with which the use of medium-size units has increased. However, the number of such units is increasing, even though not by leaps and bounds, and it behooves the steam engineer to become familiar with their operation; he cannot afford to sit idly by until they are forced upon him, but should educate himself as to all their salient features and be prepared to take advantage of an opportunity (or to meet an exigency, as the case may be), which may develop any day.

Lest We Forget

In these days of many magazines, books, papers and reviews, the average man is sorely put to it to know what to read and after he has read to know how to remember. This is as true of technical as it is of general literature; to the engineer, the manufacturer, the business manager, there comes the troublesome question, "How much of this mass of material must I read or skim or index, how can I tell what I may want and how can I ever find it if I do want it?"

The reading tables of our best technical libraries and clubs contain from fifteen to thirty periodicals, all bearing more or less directly on technical and commercial life and containing what is newest and best of information concerning the business of the world.

The engineering books on the shelves are frequently out of date when they leave the hands of the printer and it is to periodical literature that the engineer must look for the latest developments in any branch of technology or science.

It is out of the question for a busy man of affairs to read even a small part of the articles thus displayed, and yet, such is the caprice of fate, any one he neglects may later be the one most necessary to him. Many plans for solving the problem have been proposed and one rarely scans a technical journal that he does not find some new recipe for canning information. The trouble with most of them is the gradual accumulation of comparatively useless material, bushels of chaff with but a few grains of wheat. It is something like the old New England mania for saving all scraps in the hope that they would sometime be useful. Buckles, bolts, hinges, hasps, straps, sheet metal, wire, accumulated in the shed or the attic until those receptacles overflowed. "Many were called but few chosen"—and so it is apt to be with journalistic scrap.

Some of the methods proposed, arranged in the order of their completeness, may be mentioned as follows:

First. Binding all journals taken and relying on the index in each volume.

Second. Cutting out all desirable articles or items and filing them in cases with subject indexes.

Third. Relying upon the nearest library for files and purchasing standard engineering and technical indexes.

Fourth. Keeping a private, special card index and going to the library for material.

The first plan is too costly and too cumbersome both as to the initial outlay and as to its subsequent use. It is too much of an undertaking to hunt the back numbers of journals for information, no matter how great the need.

The second is better and, if carried out intelligently, may serve the purpose fairly well. The rapid accumulation of material often causes the system to break down the second or third year.

Number three is better yet, if the files of periodicals are readily accessible. It has this one serious drawback—an index, however good, which is prepared by others may not help you to find what you seek.

The last method does away with this difficulty. Every engineer should make his own index in his own way and he will then be able to find what he wants in the same way.

Perhaps it is superflous to make suggestions when so much has been written on this subject, but it would seem that a combination of some of the methods indicated previously might lead to good results.

The firm or the individual should take two or three journals which deal most directly with the business in question. Clippings from these can be filed and indexed but the selection must be carefully made, and by the engineer, not by the office boy. If a periodical is particularly valuable to the business, two copies can be taken, one to bind and one to clip.

For other journals of less immediate interest, the technical indexes can be used. In addition to these, a special card index should be made covering all the important articles, items or paragraphs which bear immediately on the work of the firm or of the individual, so designated as to be readily found.

When in doubt *do not* clip or index, for a scarcity of material is better than an overloaded collection. Once a year go over the clippings and discard any of doubtful value; in the same way remove from the file, cards which have outlived their usefulness, for only in such ways can the material be kept within such bounds as to be of practical use.

In general, technical information of this character ceases to be of much value after five years or more have elapsed and its presence is a hindrance rather than a help.

Like the cowboy and his revolver, you do not often want an index but when you do, "you want it powerful bad, and you want it quick."

Try to have your own clipping bureau and your own index and you will not regret the time and trouble involved.

When a gas engine commences to miss it is usually the case that the igniter plugs are fouled. Tangye has a ratchet wheel attached to the head of the plug on the outside of the cylinder, and a pawl which rotates it one tooth with each revolution of the lay shaft.

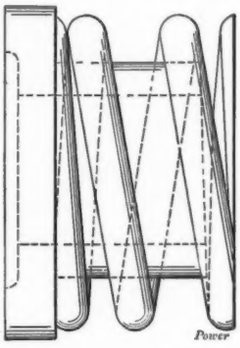
New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

The Weisz Packing Adjuster

This device consists of a steel bushing on which a steel spring is fitted, as shown in the accompanying illustration.

The bushing and spring are placed in the stuffing box and are followed by sufficient rings of packing to fill the stuffing box, as under ordinary conditions. The stuffing-box gland is then screwed up in



BUSHING AND SPRING

the ordinary way, which puts a tension on the spring. As the packing wears, the spring keeps it snug against the rod.

This packing adjuster is made by F. G. Weisz, 117 Weldon street, Brooklyn, N. Y.

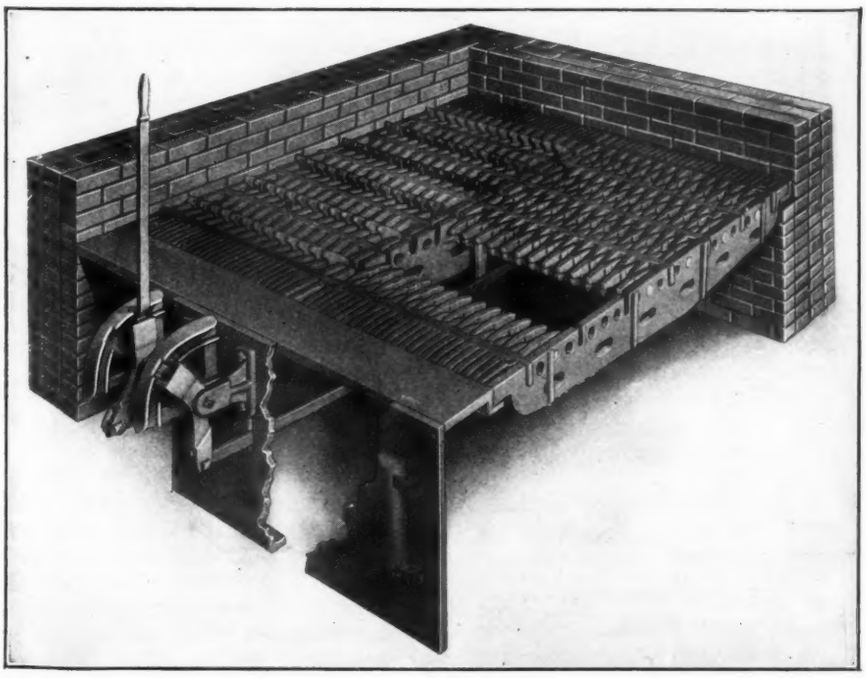
The Twentieth Century Rocking Grate

The accompanying illustration shows the details of this grate, which is made by the Water-Arch Furnace Company, 1252 First National Bank building, Chicago, Ill.

The grate consists of alternate sets of fixed bars between which is a rocking element, the fingers of which work between fixed projections on the stationary parts. The movement of the rocking element produces a powerful slicing and clinker crushing action, thereby forcing open the entire air space of the grate, removing the bottom layer of ash and clinker to the ashpit and allowing a free passage of air to the burning fuel.

The parts of the grate are designed for strength, resistance to wear and have ample cooling surface. The rocking bars are held in their bearings without the use of keys, catches, or other special devices, and by means of a self-locking rocker head it is impossible to leave the moving fingers projecting into the fire to burn off.

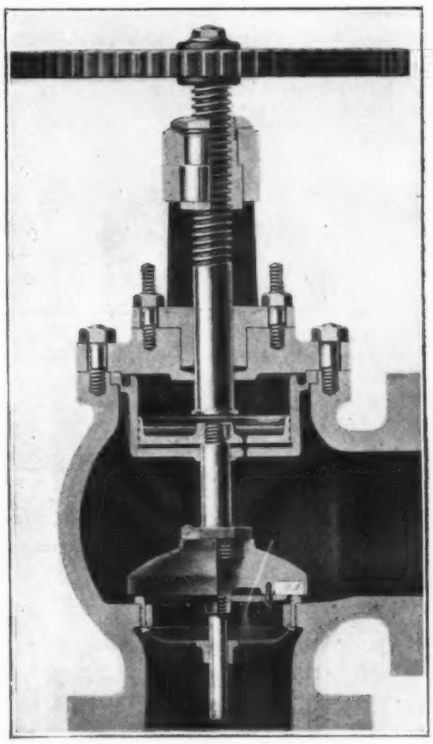
This rocker head compels the operator to center the rocker bars in place after shaking before the handle can be withdrawn, thus preventing any mistake by new or inexperienced help. All parts are interchangeable, built to withstand the hardest conditions of forced firing with clinkering coals, and there are no right- and left-hand parts in the construction, thus simplifying repairs. The air space represents 53 per cent. of the total of the grate and low-grade coal has been burned at a rate of 40 pounds per hour per square foot of grate surface, it is claimed.



SHOWING ELEMENTS OF GRATE

Automatic Equalizing Stop and Check Valve

This valve herewith illustrated is designed to automatically shut off the flow of steam from the header to a boiler in case a tube should burst or other internal rupture occur, thereby suddenly



SECTIONAL VIEW OF EQUALIZING STOP AND CHECK VALVE

reducing the pressure in that boiler. It also equalizes the pressure between the different boilers in a battery, preventing one boiler from working at a lower pressure than another. As the valve can only be opened by the pressure in the boiler to which it is attached, it is impossible to accidently turn steam into a boiler which is being cleaned.

The valve is cushioned, to prevent chattering, by an internal bronze dashpot. This eliminates the danger of sticking

through corrosion of the dashpot or piston. The valve is designed to be installed in a vertical position and is furnished in extra-heavy pattern only, in sizes of 4 to 12 inches.

The valve is made by Jenkins Brothers, 71 John street, New York City.

A Quick Acting Wrench

The wrench shown in Figs. 1, 2, 3 and 4 will turn a square, hexagon, flat or round-shaped piece which has a slight resistance in the direction of rotation desired, without removing it from the piece.

The action is positive and will not slip, it is claimed.

The shank *A* is slotted, the stock *C* is pivoted to it at *E* and is free to move in the slot except when the locking bolt *D* is pushed under the yoke *H*, in which case the wrench can be used in every way the same as the regular monkey wrench with the added advantage of having a slight friction due to the spring *I* in the adjusting screw *F* which tends to keep it set to the size it is adjusted for.

When used as an automatic wrench the locking bolt is pushed back into the stock, as shown in Fig. 2, and the wrench adjusted to size on the piece to be turned.

The action of the wrench when it is pushed backward for a new grip is as follows: First for the shank *C* to lift away from the adjusting screw *F*, then for the sliding jaw to open over the corners of the nut, then to close in again on the next flats of the nut due to the tension of the spring *I* in the adjusting screw *F*.

When the wrench is pulled forward against the shank it engages the adjusting screw *F* and is ready for another pull.

The curved surface of the spring rod *G*, which rolls on the bottom of the groove in the shank *C*, is shaped to give a slight pressure tending to close the wrench.

A detachable pipe jaw fits loosely over the jaw of the wrench and is held from falling off by the hook-shaped arms, as shown. The object of this jaw is to slip freely on the face of the wrench jaw when in use and wedge itself into the pipe or other object being turned, this forming a three-point bearing on the object and giving a grip that is sure to hold but which will release itself easily and catches readily for a new grip.

The pipe jaw is very neatly secured in the hollow handle by the spring, as shown, when not in use.

The wrench was designed and patent applied for by George W. Jessup, Jr., Newton, Mass.

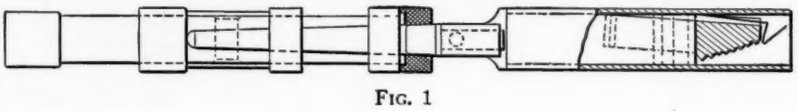


FIG. 1

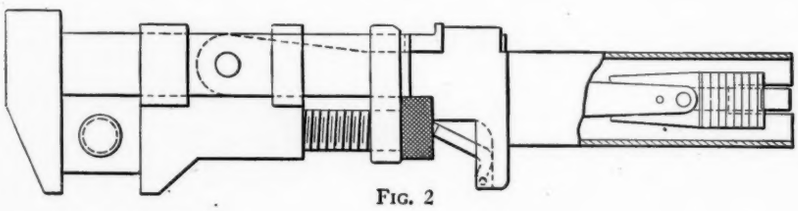


FIG. 2

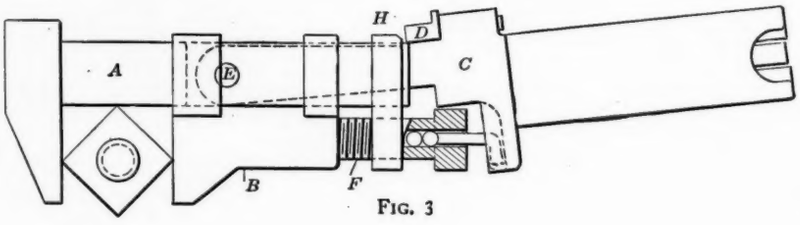


FIG. 3

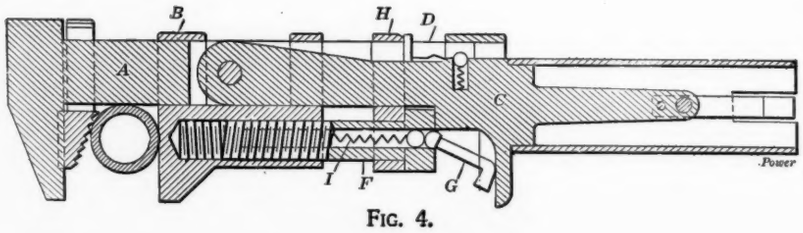
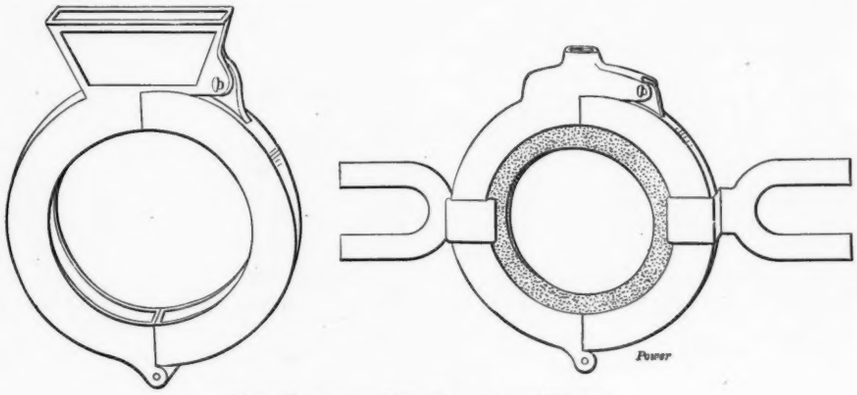


FIG. 4.

DETAILS OF THE WRENCH

Weiss Rod Oiler and Wiper

The illustration produced herewith shows two types of the Weiss oiler and wiper. One is designed for stationary engines and pumps, air compressors and condensers of the horizontal type, and the second type is designed for vertical or marine engines and vertical pumps. The latter type is bored and tapped to be connected to an oil cup at any convenient place.



TWO TYPES OF ROD OILER AND WIPER

The oil-soaked felt which lines the oiler comes in contact with the rod at all points and wipes it clean at each stroke, and at the same time lubricates the packing, which prevents friction and prevents the rod from scoring.

These cages, or oilers, are made of aluminum in all sizes from 1 inch up by the Weiss Brothers-Manufacturing Company, Detroit, Mich.

While engaged in building a mountain road from Banning to Idyllwild, Cal., large pieces of soft coal were discovered in a heretofore unexplored portion of a cañon of the San Jacinto range. An investigation will be made at once in an endeavor to locate the main deposit; such a discovery would mean a large increase of interests in southern California. The coal is of good grade and easy burning.

Keep the brickwork tight so that cold air does not enter, as it will cause fuel losses. Fire lightly and frequently and endeavor by all means to save fuel for your employer. Endeavor to carry a uniform water level when the boiler is in service. Keep the feed pumps, injectors and all other appliances in good working order and as neat as possible.

Convention of the American Boiler Manufacturers Ass'n

The twenty-second annual meeting of this association took place at the Auditorium hotel, Chicago, October 10-13, and in attendance and enthusiasm it is safe to say that no other gathering in the history of the organization approached the present one in any of its details. A steady growth has been recorded among manufacturers interested in the various types of boilers, so that while in the past a great proportion of the activity has been along the lines of marine work, the stationary field is now being represented with a stronger membership than ever before. The convention went on record as favoring specifications calling for not more than 0.03 per cent. of sulphur and 0.04 per cent. of phosphorus in boiler plate, which is in accordance with the original resolution passed on this subject some two years ago. A great deal of discussion was indulged in regarding the quality of boiler plate, those taking part being prominent representatives of the Government, State boiler-inspection bureaus and manufacturers. As a result of the deliberations a standardization committee was appointed to report at the next meeting and it was decided to work toward the adoption in this country of a uniform set of specifications for boilers for stationary purposes somewhat similar to those required in marine work.

All of the old officers were reëlected, as follows: E. D. Meier, New York, president; J. D. Farasey, Cleveland, secretary; Joseph F. Wangler, St. Louis, treasurer; T. M. Rees, Pittsburg, first vice-president; J. Don Smith, Charleston, second vice-president; W. A. Brunner, Phillipsburg, N. J., third vice-president; H. D. MacKinnon, Bay City, Mich., fourth vice-president, and M. A. Ryan, Duluth, fifth vice-president.

While the entertainment features were of the most liberal character, consisting of theater parties, automobile rides, banquets, etc., which are usual at such meetings, probably the most interesting affair was a trip to the Gary steel mills, by special train, as guests of the United States Steel Corporation. The visitors were even provided with a special train within the grounds and taken to all parts of the large works which were thoroughly inspected before leaving. On the return trip a buffet lunch was served in the Pullman cars.

The association was also the guest of Joseph T. Ryerson & Sons, at a luncheon at Lawndale, Thursday afternoon, and in the evening occurred the farewell banquet at the Auditorium hotel.

Boston was selected as the place of the next annual meeting.

MEMBERS OF AMERICAN BOILER MANUFACTURERS' ASSOCIATION ON TRIP OF INSPECTION AT GARY STEEL MILLS

Boiler Explosion

At Union City, Ind., on October 11, a boiler belonging to Witham & Bowen, lumber dealers, exploded. One man was severely injured and considerable property damage resulted. Further details will be given in an early issue.

Steam Meter Presented to University of Illinois

The General Electric Company, of Schenectady, N. Y., has presented the University of Illinois with a recording steam meter. The gift was transmitted on behalf of the company by its sales manager, F. G. Vaughen, to Prof. Ernst J. Berg, in charge of the department of electrical engineering. Earlier in the year the university was presented with a 100-kilowatt Curtis steam turbo-generator which now constitutes a part of the equipment of the electrical laboratory.

Correction

In H. J. Westover's article, "Loss in Coal Due to Excess Air," published in the October 11 issue, page 1808, third column, fourth paragraph, second line, the word *closed* should have been used instead of *opened,* making the sentence read: This is the gas formed when the damper is suddenly closed at a time when a very bright fire is burning.

Head Severed by Compressor Flywheel

At Aspen, Colo., on October 7, while tightening a loose bearing nut on a compressor in the Smuggler Mining Company plant, the foreman of the compressor department was instantly killed by being crushed in the 5-foot flywheel of the machine.

The foreman noticed the loose nut while inspecting the machine and had the compressor stopped. To tighten the nut properly it was necessary for him to put his head and shoulders through the spokes of the wheel, which suddenly turned backward, crushing him against the machine and severing his head.

The body was jammed in the wheel in a manner that necessitated the cutting of several of the neck cords before the body and head could be released.

The Snee Wave Motor

The Snee wave motor has fulfilled our estimate of its abilities and value. Above the big installation of concrete and iron upon the Million Dollar pier, at Atlantic City, there stands a windmill tower with a small windmill, differing from the ordinary form only in the curvature of its blades and bearing the sign—American Power and Manufacturing Company, 410 Union Bank building, Pittsburg, Penn. We learned that Mr. Snee has turned his attention from harnessing the sea to catching the winds, and that stockholders in the Snee Motor Company have been given a proportionate amount of stock in the windmill concern.

George M. Douglass, chief inspector of the Casualty Company of America since its formation, and head of the boiler, flywheel and inspection departments since May, 1909, has severed his connection with the company. Mr. Douglass will take a much needed rest from his recent arduous work in connection with the three departments before again engaging in business.

SOCIETY NOTES

The next meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers will be held at Springfield, O., on November 18 and 19.

BOOK RECEIVED

WORLD CORPORATION. By King C. Gillette. The New England News Company, Boston, Mass. Cardboard; 240 pages, 6x9 inches. Price, $1.

APPLIED THERMODYNAMICS. By H. W. Spangler. John Jos. McVey, Philadelphia, Penn. Cloth; 160 pages, 6⅛x9¼ inches; 76 illustrations; indexed.

MACHINE DRAWING. By Gardner C. Anthony. D. C. Heath & Co., Boston, Mass. Cloth; 104 pages, 7½x6 inches; 127 illustrations. Price, $1.50.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS. By a staff of specialists. McGraw-Hill Book Company, New York. Morocco leather; 1497 pages, 4¼x7¾ inches; illustrated; indexed. Price, $4.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

PUMPING ENGINE. Burt O. Gage, Warren, Mass., assignor to Warren Steam Pump Company, a Corporation of Massachusetts. 972,357.

EXPLOSION MOTOR. Charles Francis Jenkins, Washington, D. C. 972,379.

EXPLOSION ENGINE. Charles Francis Jenkins, Washington, D. C. 972,380.

INTERNAL COMBUSTION ENGINE. Geo. F. Swain, Chicago, Ill. 972,409.

TURBINE. George Westinghouse, Pittsburg, Penn. 972,421.

MOTOR WHEEL. James N. Johnson and John H. Johnson, Flomaton, Ala. 972,453.

CONTINUOUS COMBUSTION HEAT ENGINE. Walter F. Brown, Worcester, Mass. 972,504.

GAS ENGINE. George P. Law, Lansing, Mich. 972,547.

ROTARY ENGINE. Vernon L. Capwell, Dorranceton, Penn., assignor to the Rotary Engine and Valve Developing Company, Dorranceton, Penn. 972,598.

GAS TURBINE ENGINE. William A. Reed, Hollywood, Cal. 972,642.

TURBINE. Max Glans, Vienna, Austria-Hungary. 972,762.

ELASTIC FLUID TURBINE. William J. A. London, Hartford, Conn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 972,788.

BOILERS, FURNACES AND GAS PRODUCERS

CRUDE-OIL BURNER. William D. Patton, Dallas, Tex. 972,401.

BOILER. Albert G. Sherman, Buffalo, N. Y. 972,580.

ROCKING-BAR FURNACE GRATE. Edward T. McHugh, Holyoke, Mass. 972,707.

FEED-WATER HEATER AND SMOKE CONSUMER. George C. Miller, Fitchburg, Mass. 972,772.

POWER PLANT AUXILIARIES AND APPLIANCES

DETACHABLE BOILER FLUE. John M. Crozier, Minneapolis, Minn. 972,164.

AUTOMATIC STEAM CUTOFF VALVE. George W. Collin, Bridgeport, Conn. 972,338.

BLOWOFF VALVE. Frank P. Hamilton, Cleveland, Ohio. 972,370.

BOILER-FLUE CLEANER. Robert O. Hodge, Buffalo, N. Y. 972,374.

VALVE SPRING RETAINER. Oscar Blomberg, Muskegon, Mich. 972,434.

STARTING GEAR OF INTERNAL COMBUSTION MOTORS. Paul Daimler and Alfred Vischer, Unterturkheim-Stuttgart, Germany, assignors to Daimler Motorengesellschaft, Unterturkheim-Stuttgart, Germany. 972,512.

VALVE. Wilbur B. Burke, Cleveland, Ohio. 972,677.

LUBRICATING DEVICE. Luther K. Smith, Moberly, Mo. 972,659.

LUBRICATOR. Lewis Jackson Maloy, Copperhill, Tenn. 972,701.

FLUID PRESSURE VALVE REGULATOR. Thomas M. Wilkins, East Randolph, N. Y., assignor of five-sixteenths to W. E. Zierden, Johnsonburg, Penn., one-fourth to John G. Whitmore, Ridgway, Penn., and seven-sixteenths to Ziermore Regulator Company, Johnsonburg, Penn., a Corporation of Pennsylvania. 972,744.

CHAIN GRATE. Edward C. Clark, Nutley, N. J., assignor to the Oscar Barnett Foundry Company, a Corporation of New Jersey. 972,751.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRICAL SYSTEM OF DISTRIBUTION. Albert S. Hubbard, Belleville, N. J., assignor to Gould Storage Battery Company, a Corporation of New York. 972,536.

ELECTRIC SIGN FLASHER. Roger D. DeWolf, Pittsburg, Penn. 972,516.

ELECTRICAL INDICATOR. Edward E. Craig, Kansas City, Mo. 972,682.

SYSTEM OF ELECTRICAL DISTRIBUTION. Justus B. Entz, Philadelphia, Penn., assignor to the Electric Storage Battery Company, Philadelphia, Penn., a Corporation of New Jersey. 972,782.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.